Introduction

Welcome from the President

Welcome to the 2010 BEVA Congress! Our theme this year is: “The Art and Science of Veterinary Medicine”. The scientific programme has been carefully designed to reflect this theme by including a number of comparative lectures which will be presented by experts in the field of human medicine, alongside similar topics presented by veterinary specialists. These include sessions on twin management in humans and mares; on the complications of obesity in horses and humans; on metabolic syndrome in horses and humans; and a presentation on ultrasound-guided regional anaesthesia in people to round off our session on regional anaesthesia in horses. The aim is to stimulate debate and discussion, and to explore the place of veterinary medicine within a greater context in the medical world.

Amongst this innovation, you will find many of the tried and trusted favourites of BEVA Congress which allow delegates to get involved and join in, such as Sue Dyson’s ever-popular lameness panel; and the imaging panel (this year with a pre-purchase exam focus); and the “news hour”. You are able to see for yourself, when you read the programme, what a wide range of international and national speakers we have been fortunate enough to attract. They will be disseminating their knowledge not only in traditional lecture-based format, but also via multiple panel/discussion sessions, which range from the late pregnant mare and neonatology to wound management; and from dentistry to issues such as how to set your prices; how to know if you can afford a new assistant, and how to market your practice without wasting money. Our multinational speaker base is also reflected in the programme, which includes a special “European” session at which representatives from several of BEVA’s sister associations will be comparing practices and points of view.

When you look through the programme, you will find that the sessions range from core skills aimed at relatively recent graduates to state-of-the-art specialist lecture presentations. Favourite topics such as ophthalmology; medicine; cardiology; neurology; lameness; colic and orthopaedics are there, but some have been given an unusual twist: the nursing programme, for example, has a whole session devoted to ethics which considers subjects such as how to cope with nursing sick horses and how we determine when enough is enough. Amongst the medicine and the surgery are additional topics which relate to the art of veterinary medicine such as working within the Cascade and the EU working hours directive; the mental health of veterinary surgeons and even how to avoid being sued!

As you would expect in a year when the President is a reproduction specialist, there is a strong programme of theriogenology, perinatology and neonatology in 2010, which is flagshipged by the plenary lecture “Assisted Reproduction Technologies (ART) in the horse - a review from artificial insemination to cloning”. World-renowned reproduction specialist Dr Angus McKinnon will be travelling all the way from Australia to present this review of how far we have come in terms of reproductive technologies, and Vet-turned-barrister Dr Justin Turner will provide comment on some of the legal challenges which such developments have thrown up.

The “Art and Science theme” is also reflected in the social events which we have planned. The President’s reception this year will take place within the commercial exhibition, and will include illustrated talks by the veterinary history society, by the curator of the equestrian works within the Birmingham museums and a slide show by equine photographer Henry Dallal. Come and enjoy some food, wine, shopping and culture all under one roof, whilst meeting up with friends at the start of Congress. Thursday night is happy hour within the commercial exhibition and also the careers fair - something which was really popular when we first held it in 2009 and which provides a great chance for Practices and prospective employees to meet and chat. On Friday night, it is time to don your glad rags and to enjoy a black-tie dinner followed by dancing and a chance to gamble your fortune away at the casino which is being run in aid of the BEVA Trust and for which a truly fantastic prize of a one night midweek stay at Coworth Park for two people with dinner and a riding lesson or hack in Windsor Great Park which has been kindly donated by Coworth Park, one of the Dorchester Collection group of iconic luxury hotels. All this within the confines of the ICC so there is no need to travel anywhere and no excuse for not being back in the lecture halls bright eyed and bushy tailed on Saturday morning!

The Congress committee has designed a programme which we hope will appeal to delegates at all stages of their careers, whatever sector of the equine veterinary industry they may work within. BEVA Congress represents a unique opportunity to come and benefit from some of the best equine CPD available anywhere in the world, whilst enjoying the social events and meeting up with friends. I am delighted that you are here to share it.

Madeleine Campbell
BEVA President 2010

Proceedings of the 49th British Equine Veterinary Association Congress 2010 - Birmingham, United Kingdom
BEVA Rewards Excellence
Each year BEVA presents awards to the brightest and best in equine veterinary medicine to honour their outstanding contributions in the field.

The BEVA Equine Welfare Award, sponsored by the Blue Cross
The winner of this year’s prestigious BEVA Equine Welfare Award is Ms Jo White.

Ms White joined World Horse Welfare in 2001 and is responsible for running the campaigns department, covering all of the research, political lobbying and profile raising elements needed to run World Horse Welfare’s operational campaigns. The charity’s major campaign is to end the long distance transport of horses for slaughter in Europe.

Ms White has put herself on the frontline of the campaign - embarking on countless field trips to gather evidence - often dealing with unpleasant individuals and difficult situations.

This field evidence formed a key element of a dossier that was handed to the European Commissioner in November 2008 highlighting the inadequacies of current regulations, the abuse of these regulations, and the horrific suffering inflicted on around 100,000 horses in Europe each year.

Ms White coordinated the publication of this dossier over a seven year period - combining the field research with scientific and desk research.

Written declaration 54/2009 - calling for an immediate amendment of the transport regulation - was adopted by the European Parliament in February 2010. This involved getting over half of all MEPs to sign the declaration. This achievement is in no small part due to Ms White’s efforts.

The BEVA Richard Hartley Clinical Awards

This award is given in memory of Richard Hartley, a founder member of BEVA and president from 1974–1975. It is awarded for evidence-based papers and the prize is intended to support travel of the senior author and/or co-authors.

The BEVA Trust EVJ Open Award
The winner of this award is Dr Richard J. Piercy et al. for the paper, “A glycogen synthase 1 mutation associated with equine polysaccharide storage myopathy and exertional rhabdomyolysis occurs in a variety of UK breeds” published in the July 2009 issue of Equine Veterinary Journal.

The BEVA Trust Queen Mother Award
This is awarded for the best travel report written by a Queen Mother Student Travel Award recipient. This year’s winner is Katherine Wells, who reported on her visit to Clovelly Intensive Care Unit at Scone Veterinary Hospital in Australia.

If you would like to read Katherine’s report it is available to view on the BEVA Trust section of the BEVA website www.beva.org.uk

The Voorjaarsdagen and BEVA Awards
In 2005 the Voorjaarsdagen and BEVA Awards were introduced to mark the close relationship between the two Associations. The award is selected and presented biannually, once at the Voorjaarsdagen Congress and once at BEVA Congress, and is open to all those presenting a Clinical Research paper.

This year’s BEVA Award winner is Dr Franca Jonquiere of the University of Utrecht. Her paper “MRSA prevalence in healthy horses in the Netherlands: A follow-up study” was first presented at the Voorjaarsdagen Congress in April 2010 and will be presented in the Clinical Research Sessions on Saturday 11th September.

The Voorjaarsdagen Award winner will be selected from those presenting a Clinical Research paper at this year’s BEVA Congress. Their prize will be an expenses paid trip to the Voorjaarsdagen Congress 2011 where they will have the opportunity to present their paper again.

The Sam Hignett Award
All Clinical Research presentations from general equine practice are eligible for the Sam Hignett Award. A continuous process of assessment will take place throughout the Clinical Research Sessions and the winner of the award will be announced after Congress through the BEVA website and newsletter.

The above awards will be presented during the President’s Lunch on Thursday 9th September.
Proceedings of the 49th British Equine Veterinary Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

BEVA Congress
British Equine Veterinary Association
7-10th September 2011 • Liverpool, UK

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This year BEVA has named the imaging panel in memory of Alastair Nelson. Below is a touching tribute from his practice partner Bob Ordridge

When Alastair joined the REC he came on the understanding that we build a new diagnostic room in which to house an overhead x-ray unit and a nuclear bone scanner. This would mean a large capital outlay because of the health and safety regulations and the need for 3 phase electricity to power it all.

I remember looking at my partner Ieuan Pritchard and thinking what were we letting ourselves in for? We could be getting too big for our boots, advancing too quickly and out of our comfort zone.

We had no need to worry for Alastair was ahead of his time. A Cambridge graduate, one of a rich vein of contemporary veterinary surgeons who had the ability to think and to apply tunnel vision to whatever needed to be achieved. His goal was to take the technology and equipment found in the universities and to use it to push the REC to the frontline of diagnostic imaging.

As time went by I found myself relying more and more on his knowledge to answer my questions instead of me looking things up. As a result I will probably miss him more than others and will need to get used to reading again.

Alastair would purchase second hand equipment from hospitals and learn how to install them and to make them work. He seemed to be able to tweak them, mix and match parts from here and there and never seemed to read the user manuals.

The installation of the CT unit was Alastair’s greatest achievement. His ideas of having the horse standing sedated in a pit so as to reduce the necessity of a general anaesthetic when imaging the head and neck was pure genius and is being copied all over the country and by now the world. In fact Alastair was involved with his system installation at many universities and equine veterinary practices.

I think that his best idea was to transport the horse on 4 mini compressed air units so that they floated on a bed of air like hovercrafts. This removes the friction as they glide effortlessly through the tunnel of the machine.

But Alastair was much more than an exceptional and gifted veterinary surgeon. I cannot ever remember him talking badly of anyone. The only time he lost his composure was when a horse tried to kick him or would not stand still when being injected.

He was able to organise his life into 3 main parts and to make the time to be
1. A veterinary surgeon
2. A devoted father to his 2 children Eve and James and husband to his wife Elizabeth
3. And to train and compete as a very fine athlete in his chosen sport of triathlon.

He was also in the process of becoming a swimming instructor so that he could teach others.

It was an honour to have worked with Alastair and to have him as a business partner and friend.

But most of all it was a pleasure to have known him as a person and I know that it will be a very long time for all of us at the REH to accept that he will not be coming back to work with us.

How do I best remember him? He was a man with a very tidy and organised mind but a very untidy car and desk.
Oral examination is essential for the accurate diagnosis of dental and oral pathology. Initial assessment of information from the owner such as reason for examination, riding history, eating history, dental care history and clinical signs will give an initial idea of the type and degree of examination required. Distant observation of the horse is useful to assess signs such as dropped food, nasal discharge and faecal output. It is important not to overlook nondental diagnoses when examining the patient.

Clinical examination should begin with assessment of the horse in general, condition score and lymph node enlargement are particularly important. With basic oral examination in a well-behaved horse sedation is rarely necessary. However, where the temperament of the horse or clinical signs indicate a more detailed examination, sedation should be used. Cardiac auscultation should be performed prior to administering sedatives.

Oral examination begins with assessment of the external head looking for facial symmetry, swellings, nasal discharge, lymph node enlargement and masseter muscle condition. Oral or nasal malodour may also be detected.

Incisor examination should be performed prior to placing the speculum. The number, any malocclusions, signs of stereotypic behaviour, calculus build-up and periodontal disease should be noted. A lateral excursion test as an aid to assessing molar occlusion may be useful but should not be overinterpreted. If there is severe incisor pathology then alternative designs of specula may be required to assess the caudal oral cavity.

The speculum should be placed carefully to avoid trauma to the patient, owner or yourself. For a detailed oral examination flushing the mouth using a 500 ml dosing syringe is essential. Collecting the wash prevents a wet floor which may be a hazard to footing or for electrics. Manual examination should be performed using thin nitrile or latex gloves to improve hygiene. The interdental space should be assessed for canines, wolf teeth and injury to the bars. The cheek teeth should be assessed for number of teeth, sharp edges, large occlusal disturbances, displacements and fractures. This should be repeated for all 4 arcades. The soft tissues (palatal mucosa, buccal mucosa and tongue) should be palpated for signs of ulceration and/or masses.

A visual examination should follow manual examination. A bright headlight should be used aided, when required, by a dental mirror. This can retract soft tissues such as the tongue and cheeks to allow a better view. It also allows perpendicular examination of the occlusal surface, soft tissues and interproximal spaces. This is particularly useful for evaluating periodontal disease, endodontic disease, caries and soft tissue conditions in the caudal oral cavity. The use of a periodontal probe to assess periodontal abnormalities and an occlusal surface probe to assess occlusal abnormalities such as pulp exposure can greatly increase the information gained from an oral examination but requires sedation. These, when used alongside diagnostic imaging, can be invaluable in determining the diagnosis and best treatment for individual cases.

Finally, all findings should be recorded on a dental chart using the Triadan numbering system.

NOTES
Routine floating - performance or mastication?

Torbjörn Lundström

Section of Large Animal Medicine and Surgery, Department of Clinical Sciences, Swedish University of Agriculture Sciences Box 7054, 75007 Uppsala, Sweden.

Some treatments in health care are executed so often that from time to time we forget why we are doing them. Routinely floating the teeth of the horse is one of these. In the effort of executing evidence based medicine we currently have to reflect on why we are performing a treatment. In equine dentistry sharp enamel points will be diagnosed frequently and floating the teeth comes subsequently. But does routine floating of the teeth of the horse improve mastication and performance? It is debatable, especially if executed without a thorough oral examination.

Routine floating must be stated to be the most common dental treatment in equine dentistry. The purpose of floating the teeth of the horse is to remove enamel points not worn down by normal attrition during mastication. Incompletely worn enamel points could be a problem for the horse when eating and may interfere with the soft tissues of the oral cavity and with equipment when the horse is ridden or driven. Thus routine floating has been accepted as an essential treatment in equine dentistry. This is, of course, if we accept the fact that horses do not inherently have a functional dental attrition process. We may well take a different stand if we look upon incomplete attrition of the occlusal surfaces of the teeth of the horse as being the result of a disturbance of mastication.

Epidemiological data reveals many different maladies which can cause disturbances in the motion of grinding. For example, dental fractures found in about 10% of equine patients may cause pain of varying severity and nature and thereby act as a restrictor in the normal grinding movements. Different physiological occurrences, like exfoliation of deciduous teeth, is another example where pain may influence the masticatory pattern. Different types of teeth are not only worn down in a normal way. The soft tissue can easily become jammed between the bit, or the noseband, and the teeth. Common disturbances/abnormalities, for example, mesial (rostral) hooks on the first cheek teeth, will intensify the problem. Floating might be of relief for some individual horses, at least temporarily, but corrections of the equipment could be, in many cases, a more successful way of improving performance. Or possibly, a combination of correction of the equipment and a treatment which addresses the primary cause of the problem.

Dentistry is about optimising performance, mastication and, above all, the well being of the horse. It involves consideration of the tooth, horse, equipment, intended use of the horse, diet and environment in which the horse lives and performs. It requires an understanding that horses have evolved with a functional dental attrition which has not all been lost in the process of domestication. It also requires an understanding that deviation from normal mastication is reflected in oral and dental abnormalities and that if the underlying cause can be diagnosed then an appropriate treatment may be possible with a permanent return to normal mastication and thus functional dental attrition. Routine floating has the potential to fail to address underlying causes of oral pathology. The treatment of each individual tooth should be justified on the merits/diagnosis of each single tooth. This consideration allows us to continue to aspire to, practice and develop evidence based medicine for dentistry. Overall, the importance of a thorough oral examination with appropriate diagnostics and consideration for the horse as a whole cannot be overstated.

Further reading

Andersson, J. (2010) Själfhastheten för dentin och cement i förhållande till emalj i vivo hos häst. Online publication of this work; //epsilon.slu.se ISSN 1625-8697.

Thursday 9th September 2010


Wolf tooth is the common term used to describe upper and lower first premolars (105, 205, 305, 405). Wolf teeth generally erupt between 6–18 months of age, but this may be quite variable. Forty to 80% of domestic horses erupt at least one wolf tooth with lower wolf teeth being much more rare. Double wolf teeth on one side occasionally may be observed. Wolf teeth are often concurrently shed with the deciduous 2nd premolar (506, 606, 706, 806) which would lead to the decreased percentage (15–20%) of horses over 2.5 years having wolf teeth present. The erupting permanent 2nd premolar often causes resorption of the wolf tooth root if it is positioned in close proximity to the deciduous 2nd premolar. This may result in loss of the wolf tooth as the deciduous 2nd premolar is shed. This may also result in a shortened root of the wolf tooth which will then falsely appear broken when extracted.

On oral examination the interdental space should be palpated digitally as well as observed visually. Wolf teeth are generally positioned in close proximity to the 2nd premolar. Wolf teeth displaced rostrally in the interdental space often erupt at an angle and may not break through the gingiva. Unerupted wolf teeth, often referred to as ‘blind’ wolf teeth, are palpated as firm nodules under the oral mucosa rostral to the 2nd premolar in the interdental space and may occur on the upper or lower jaw. These teeth are often painful and over time may become exposed as the oral mucosa becomes ulcerated by trauma from coarse feed materials or the bit.

Historically, there has been much controversy involving the role of wolf teeth in causing oral pain. The fact that these vestigial teeth do not serve a purpose and may possibly cause discomfort and training issues has resulted in the common practice of extracting wolf teeth. Sharp wolf teeth may cause buccal ulcerations and pain when the noseband or bit forces the soft tissues into these teeth. Wolf teeth in the young horse are often slightly mobile and bit contact may cause pain as the horse is ridden. Loose or diseased wolf teeth may also cause oral pain and contribute to training problems. Lower wolf teeth and ‘blind’ wolf teeth or wolf teeth positioned rostrally in the interdental space are frequently contacted by the bit and cause pain and major training problems. Due to the close proximity of the wolf tooth to the 2nd premolar it can be impossible to round the rostral edge of the first cheek teeth. Some veterinarians float or grind the wolf teeth or wolf teeth positioned rostrally in the interdental space often erupt at an angle and may not break through the gingiva. Unerupted wolf teeth, often referred to as ‘blind’ wolf teeth, are palpated as firm nodules under the oral mucosa rostral to the 2nd premolar in the interdental space and may occur on the upper or lower jaw. These teeth are often painful and over time may become exposed as the oral mucosa becomes ulcerated by trauma from coarse feed materials or the bit.

Any time a wolf tooth appears abnormal or unusual radiographs may be used to evaluate the root structure and position. It is often useful to radiograph ‘blind’ or unerupted wolf teeth. These may occur in the upper or lower interdental space and should be differentiated from exostosis or periostitis, which most often occurs from bit trauma to the bone surface. Impacted wolf teeth are generally easy to extract. After the tooth is blocked with local anaesthesia, an incision may be made over the distal lateral aspect of the tooth with a scalpel or sharp elevator. The soft tissues should be carefully elevated from around the tooth. Due to the angled eruption of these displaced teeth, the elevator may be inserted from the rostral dorsal side of the tooth and downward pressure applied to remove the tooth. The tooth should be carefully inspected to ensure the complete tooth has been extracted and a fractured piece of the root does not remain. Impacted wolf teeth are generally small and completely covered in cementum. Due to the position of these teeth, the root fragment should be removed if a fracture occurs. Occasionally impacted wolf teeth and lower wolf teeth may be very large and radiographs should be used to evaluate the root structure.

Further reading/references
‘Seating the bit’ - necessary or nonsense?

Jack Easley
PO Box 1075, Shelbyville, Kentucky 40065, USA.

Primum non nocere (First, do no harm), Hippocrates (circa 460–377 BCE)

Horses have been subdued with bit and bridle for over 5000 years. Man first fashioned bits from plaited vines, wood, antler and bone. Bronze bits were introduced about 3000 years ago, followed by copper, iron and steel. More recently, bits have been fashioned from stainless steel, plastic and other synthetic materials. Modern bits and bridles place pressure on at least 8 areas (mouth, bars, lips, cheeks, tongue, hard palate, chin groove, nose and poll) of the horse’s head (Bennett 2010).

Oral ulcerations and injuries caused from the bit were recognised and recorded in early veterinary literature (Youtt 1831; Dadd 1860). These were first thought to be caused from the bit pulling the oral soft tissues against sharp enamel points on the cheek teeth. Sharp teeth have been blamed for ‘bad behaviour’, ‘lugging out’ or ‘off leg lameness’ and have been associated with oral ulceration and cheek pain. Sharp points on the lower cheek teeth have been associated with bit injuries to the tongue (Dadd 1860). The remedy recommended to alleviate these problems was ‘the rasp’. Mayhew described injuries caused from the harsh use of the bit in the lip commissures, cheeks, tongue, bars of the mouth and chin groove. He recognised early on that all these injuries were not attributable to sharp tooth points (Mayhew 1888).

In the early 20th century, ‘dressing of teeth’ became more of a common procedure. Sharp enamel points were thought to attain the greatest size in the 5–8-year-old and they could wound the cheeks of drivers, reiners and saddle horses. On this subject, Merillat gave the following comment: “The aim in dressing the teeth of a horse should be to simply blunt the enamel points along the course of the arcades and to ‘round up’ the first superior and first inferior molars as smooth as an ivory ball to allow for the seat of the bit”.

A few carefully directed strokes of the float equipped with the rasp blade will rapidly blunt the sharp projections to the desired point. Rounding the borders of the molars was unnecessary and harmful. He went on to state that sharp enamel points would begin to recur in about 3 months but not of sufficient degree to produce injury until 12–18 months (Merillat 1917).

In the mid 20th century, equine veterinarians and dental technicians described bit seating as the rounding of the first cheek teeth to reduce enamel points and contouring the teeth to decrease cheek pressure and injuries form the bit (Skewes 1962; Beeman 1962; Shidler 1983; Scrutchfield 1996). Scoggins (2001) wrote that rounding off buccal/occlusal surfaces of the maxillary and lingual/occlusal surfaces of the mandibular cheek teeth and anterior/occlusal surfaces of all four 1st cheek teeth, will help reduce discomfort induced by bits and bridles. Additionally, smoothing and shaping the last molars posteriorly allows a more comfortable relaxed lower jaw. The more aggressive the demands of the sport (polo vs. pleasure riding), the more justified is an aggressive approach to shaping cheek teeth. He described the use of hand tools and power dental grinders to perform these procedures. The danger of thermal damage to the pulp and direct pulp exposure was cautioned against (Scoggins 2001).

Two studies have shown a high incidence of oral ulcers in bitted horses as compared to horses not ridden in bit and bridle (Allen 2004; Tell et al. 2008). A more recent study confirmed that the time-held beliefs that the standard practice of floating teeth to reduce sharp buccal and lingual points (without bit seating), is not effective in preventing oral ulcerations in ridden horses (Tell et al. 2008).

A clinical study on 20 horses showed an improved trainer perception of athletic performance and responsiveness to the bit after dental floating and bit seating (Wiluszka and Rubin 1999). A later study showed no positive effect on performance post routine floating.

Controversy still exists as to the degree to which the crown of the 2nd premolar should be reduced. Complications from excessive bit seats include damage to the rostral pulp horns of the 2nd premolar (Rucker and Carmalt 2004; Bettiol and Dixon 2010). Coarse tungsten carbide blades have been shown via electron microscopy, to severely damage dental crown structures and expose dentine tubules. Power tools have the potential to damage dentine tubules and odontoblastic processes or expose the pulp from over-reducing the crown (Kempson et al. 2003; Bettiol and Dixon 2010). Motorised burrs generate heat and thermal damage to pulps is possible even though direct exposure does not occur (Kempson et al. 2003).

Bettiol and Dixon (2010) showed that you can indirectly assess the thickness of secondary dentine over the 6th pulp horn from the rostral edge of the 1st cheek tooth (06s). The greater this distance, the lower the risk of pulp exposure of the 6th pulp horn. The converse is also true. Aged horses were found to have less occlusal secondary dentine and be at an increased risk of pulp exposure.

The incidence of buccal ulcers can be quite high in horses ridden with bit and bridle. Floating bitted horses without contouring the front teeth will not prevent oral ulcerations opposite the upper 06s and in the lip commissures. Such findings and clinical evidence has led some to feel strongly that the bit is inhumane; and it certainly is, in untrained hands. Merillat (1917) mentioned bit gnathitis and recommended better mouthing or another practice recommended to reduce or alleviate bitting injuries (Cook 2006; Tell et al. 2008).

If our true mission as veterinarians is to help prevent disease and protect the welfare of the horse, we should address the issues of bitting and oral health with in-depth studies and research. We need to clearly show the proper method for safely and proficiently ‘dressing the bitted horse’s teeth’. Our primary goal is, First, do no harm.

References and further reading


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NOTES
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BEVA

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Next Congress:

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Introduction

Indications for radiography of the equine skull are numerous but most commonly include clinical signs associated with periapical dental disease, disorders of the paranasal sinuses or nasal cavities (unilateral nasal discharge, facial swelling, quidding and discharging sinus tracts). Occasionally, it may be useful to radiographically examine horses with suspected abnormalities of the guttural pouches, pharynx/arynx and traumatic injuries of the skull.

Any x-ray machine can be used to obtain good quality radiographs of the skull. Fast film-screen combinations produce the best results. The use of grids is unnecessary and is discouraged because of the associated increased exposure of handlers to radiation. Lateral views of the skull are easy to obtain, but inexperienced radiographers may find it more difficult to obtain consistently good, reproducible results for oblique radiographic views.

Patient preparation

The vast majority of equine patients will require sedation to facilitate radiography of the skull. General anaesthesia is not necessary. A rope or woven headcollar should be used to avoid artefacts from the metal buckles on a standard headcollar appearing on the radiograph. However, even rope headcollars can create artefacts on a radiograph, therefore the headcollar should be moved out of the area of interest if possible.

Tips for skull radiography

- Using a large cassette and collimating the primary beam to include a large area, e.g. the entire maxillary dental arcade and sinuses if a maxillary dental disorder is suspected, can make interpretation of skull radiographs easier as abnormalities can be related to easily identified anatomical structures.
- Resting the nose of a sedated horse on a stool can sometimes help to reduce swaying movements of the head.
- Attaching the cassette directly to the head using bungee type cords is an alternative way to prevent movement blur and means a second person is not required to hold the cassette holder.
- Use a lower exposure to view the paranasal sinus contents, incisors or guttural pouch/laryngeal areas as compared to the relatively radio-opaque cheek teeth.
- If a facial swelling is present, placing a small radio-opaque marker (e.g. paperclip) on the area of maximal swelling and taking an additional lateral or oblique radiograph can help when deciding if radiographic changes are likely to be clinically significant.
- If a cutaneous draining tract is present, a blunt, malleable, metallic probe can be gently guided into the tract and held in place with tape. This is particularly useful to definitively identify periapical infection in the mandibular or rostral maxillary cheek teeth.
- There is marked normal age-related variation in the appearance of the cheek teeth apices. Radiographing the contralateral (unaffected) cheek teeth row can be useful when deciding if a suspected abnormality is likely to be significant or not.
- Know your skull anatomy and what the radiographic view you are taking should look like!

Standard views include:

- Lateral
- Latero30°dorsal–lateroventral oblique
- Latero35-45°ventral–laterodorsal oblique
- Dorso-ventral

These views usually will provide the clinician with all the radiographic information that is required. Using a larger angle when taking oblique radiographs increases separation of structures of the left and right sides of the head, but also increases distortion of the structures the clinician is trying to assess. Additional views are occasionally necessary to clearly visualise the occlusal surface of the CT, the wolf teeth, canines and incisors, and some skull fractures.

The horse handler should keep the horse’s head level, with no axial rotation, as this will alter the angle of incidence of the x-ray beam. The rostral aspect of the facial crest gives an approximate marker for the centre of the cheek teeth rows and serves as a good centering point for radiography of the cheek teeth.

Other views that are sometimes indicated include:

- Open mouthed obliques - to view the occlusal aspect of the cheek teeth
- Introra-oral views - usually of the incisors and canines or to evaluate traumatic damage to the rostral skull
- Oblique dorso-ventral views or dorso-ventral views with offset mandible - to image one hemi-mandible or nasal cavity in particular
- Lateral views of the guttural pouches or laryngeal/pharyngeal area
- Tangential oblique views to image the temporomandibular joints

Common faults that occur during skull radiography include:

- Using too small a cassette (and missing the area of interest)
- Not knowing the proper positioning/x-ray beam direction required to get the desired view
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- Inadvertent rostro-caudal angulation of the x-ray beam, particularly when taking lateral oblique views
- Axial rotation when taking dorso-ventral views
- Inadequate exposures - although exposures vary depending on patient size and the x-ray machine and cassette systems used, typical exposures used at the author’s practice for a Thoroughbred horse are provided below:
  - Lateral: 63 kV, 6.3 mAs
  - Lateral obliques: 66 kV, 8 mAs
  - Dorso-ventral: 73 kV, 8 mAs

Further reading
Normal anatomical radiographic anatomy of the equine head

Renate Weller
The Royal Veterinary College, University of London, UK.

Teeth
The horse has 3 incisors, one canine (if male) and 6 cheek teeth in each arcade (supernumary teeth can occur in horses). In some horses there might be a wolf tooth present (1st premolar), which can be seen radiographically as a radiodense structure rostral to the first cheek tooth embedded in the soft tissues. The teeth are the densest structures in the body and appear as very radiodense structures with some less radiodense longitudinal shadows representing the infundibula and pulp running through it on radiographs. The laterolateral view provides a good overview of the teeth; however, oblique projections are required to separate the left and right arcades.

The reserve crowns of the first 2 cheek teeth are embedded within bone, the middle 2 cheek teeth extend into the rostral maxillary sinus and the caudal 2 cheek teeth into the caudal maxillary sinus. Depending on the age of the horse the reserve crowns occupy a varying part of the respective sinus. The cheek teeth erupt at varying times and become continuously shorter throughout life at a rate of about 2 mm per year. As a guideline the number of the cheek tooth when using the premolar/molar nomenclature (plus adding half a year for the last and first cheek tooth) indicates the age of the horse when they erupt, so the first cheek tooth (=2nd premolar) would erupt at 2.5 years, the second cheek tooth at (=3rd premolar) at 3 and so on. The teeth are connected to the surrounding alveolar bone by the radiolucent lamina dura denta which is only 1–2 mm in width and is often lost in cases of tooth root infections. Care has to be taken not to over-interpret this sign since the lamina dura follows the irregular outline of the teeth and is sometimes not visible depending on the projection.

The appearance of the roots itself varies between different teeth (the tooth roots of the first cheek tooth often appear rounded for example), between individuals (left-right comparison is very helpful in cases of suspected problems) and changes with age. The tooth roots can also appear rounded if the angle of the projection is obliqued in a rostrocaudal direction, which can be appreciated by the loss of the space between adjacent teeth. True tooth roots are not present in the juvenile horse and only develop over time to change from a more rounded appearance in the younger horse to become pointy with age

In juvenile horses the dental sacs present radiographically as large, round-oval shaped radiolucencies disrupted by radiodense lines representing the partially calcified tissue. The roots are surrounded by a radiolucent halo, the wide periodontal space, commonly called eruption cysts. These should not be mistaken for pathological halos caused by tooth root infections. The reserve ground of the mandibular cheek teeth may be so long that they cause bumps on the ventral border of the mandible in young horses.

Paranasal sinuses
The skull of the horse is composed of a series of bone plates, several of which have become pneumatized during evolution to supposedly reduce the weight of the head. The enclosed air spaces form the paranasal sinus system, comprising the maxillary, conchonfrontal and sphenopalatine sinus (some authors also report a separate ethmoidal sinus, while others view this as extensions of the other sinuses). The maxillary sinus is completely separated into a larger caudal (CMS) and smaller rostral part (RMS). The RMS can be subdivided into a lateral and a medial part (termed the ventral conchal sinus), which in turn has a dorsocaudal extension, the ventral conchal bulla. Both maxillary compartments are connected to the outside through the nasal passages via the slit-like nasomaxillary aperture. The other sinuses communicate with the CMS. The sinuses are air-filled structures surrounded by thin bones, which provides excellent contrast and hence appear radiolucent areas surrounded by radiodense bones on radiographs. The laterolateral projection allows the visualisation of most of the sinuses; however, left and right sides are superimposed on each other and cannot be separated in this view.

The RMS is located dorsal to the 3rd and 4th cheek tooth (4th premolar and 1st molar, 08 and 09), which are extending into the sinus filling it to a varying degree depending on the age of the horse and hence the size of the reserve crowns. Its caudal border is formed by a bony septum, seen radiographically as radiodense lines extending from the 4th cheek tooth in a dorsocaudal direction. The medial part of the rostral maxillary sinus, the ventral conchal sinus can only be radiographically evaluated on a dorsoventral or ventrodorsal projection where it is located abaxial to the midline extending from the 3rd to the 6th cheek tooth (3rd molar, 111/211). The CMS is located dorsal to the 5th and 6th cheek tooth (2nd and 3rd molars, 110, 111/210, 211) whose reserve crowns extend into this sinus. The frontal sinus is radiographically seen as a radiolucent triangle dorsal to the ethmoids and rostral to the cranium. It stands in wide open communication with the dorsal conchal sinus that extends rostrally from the frontal sinus.

The infraorbital canals are seen as 2 radiolucencies running parallel to the nose dorsal to the cheek teeth.

Nasal cavity
The nasal cavity is best evaluated on a DV/VD projection since they are superimposed onto the paranasal sinuses on the laterolateral view. Left and right sides are separated by the nasal septum, which should be straight and positioned in the midline.

Bones and joints
The various bone plates forming the skull are joined together by synostoses which are not visible radiographically in the normal horse. The basihyoid and stylohyoid can be seen as radiodense structures on laterolateral radiographs of the caudal skull. Both should be smooth in outline with the basihyoid running horizontally caudal to the temporomanibular joint, the stylohyoid extending from the larynx area dorsocaudally over the gullet pouches to articulate with the temporal bone. The temporomandibular joint is located just rostral to the very radiodense petrous bone and is formed by the head of the mandible and the temporal bone. There is often a bony protuberance on the caudal aspect of the mandibular head, especially in older horses. The zygomatic arch extend rostrally towards the orbit as a radiodense horizontal structure. The ethmoid turbinates appear as delicate scrolls of bony density rostral to the cranium, partly superimposed on the paranasal sinuses, partly on the radiodense orbits. These should be evaluated on the laterolateral as well as DV/VD projections.
Soft tissues
The larynx can be seen as soft tissue structures on laterolateral radiographs with the epiglottis protruding rostrally. In sedated horses the epiglottis is sometimes positioned ventral to the palate. The bones of the hyoid apparatus can be seen as faintly outline opacities within the soft tissues ventral to the larynx. The guttural pouches are seen as radiolucent sacs in the angle between the head and the neck on laterolateral radiographs with the stylohyoid running through it.

Further reading
Radiographic interpretation of disease of the head and teeth

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The advent of digital radiographic imaging systems and a better understanding of correct positioning and radiographic technique have enabled the clinician to enjoy better images than those evaluated in previous studies. However, despite this, recent pilot studies have indicated that interpretation of dental radiographs remains challenging. Until computed tomographic systems which enable a further advance in 3 dimensional imaging become more widely available radiography will remain the most commonly used diagnostic modality. This remains complicated by the superimposition of the different structures in the head, the challenge of collecting intra-oral radiographs, complicated anatomy of individual teeth and limited radiological responses of dental tissues to pathological insult. The projections which optimise imaging of the dental tissues and reducing superimposition have been described elsewhere.

Before attempting to diagnose radiographic changes which correspond to pathology, the clinician must have a detailed knowledge of the physiological changes which occur in the equine dentition with age and normal masticatory attrition. Physiological changes which affect the radiographs can be divided into changes to the dental tissues due to normal growth and to position as a result of dental eruption, changes to the nondental tissues surrounding the teeth as a result of these physiological changes and physiological differences between different species and breeds. The pathological responses of dental and surrounding tissues are limited and must be distinguished from the physiological changes described above. Dental tissues have a limited range of response to insult due to the high mineral component of these tissues. Enamel is minimally reactive and has very limited regenerative potential. Its high inorganic component renders it to be the most resilient tissue to decay and its limited radiological responses of the bone. Other radiological responses of the bone are focal fracture lines or neoplastic changes. The radiographic response of the bones adjacent to the teeth usually precedes the dental changes and consequently the periodontal radiological changes may be easier to identify than dental changes. Demineralisation of the alveolar bone plate will also occur during advanced periodontal disease and this can be detected most easily on open-mouthed oblique occlusal projections or dorsoventral projections which skyl ine the periodontium. Dental fracture is reliably identifiable as the presence of lytic lines which almost always traverse the tooth, most commonly in a parasagittal plane involving maxillary teeth, although transverse fractures occur commonly in incisors. Pilot studies have indicated that the most repeatable and reliable radiological response to pulpitis reported, was alveolar bone sclerosis around an infected dental root. In addition irregular widening of the periodontium and sclerosis of lamina dura denta can also be seen with pulpitis and as a result of focal periodontal disease. The presence of tracts discharging through the bone is reliable and can be enhanced by using radiopaque markers to localise the collapsed dental root. The presence of fluid menisci in the paranasal sinuses on horizontal standing radiographs is a reliable radiographic sign of sinus infection often associated with suppuration from a maxillary dental apex, but the soft-tissue radio-opacity of the exudates often obscures subtle changes to the dental apices. In view of the low sensitivity and specificity of dental radiology in horses, which is similar to other species, radiology should be interpreted in light of occlusal findings and supplementary ancillary diagnostic test.

Further reading
Proceedings of the
49th British Equine Veterinary
Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

BEVA Congress
British Equine Veterinary Association
7-10th September 2011 • Liverpool, UK

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Advantages and limits of computed tomography in the diagnosis of equine dental disease

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Introduction

Computed tomography (CT) is increasingly used in equine medicine as a valuable diagnostic tool. CT provides detailed cross sectional images of tissues with good bony and soft tissue contrast, eliminating the problem of superimposition (Heufelder et al. 1994; O'Brien and Biller 1998; Solano and Brawer 2004). CT examination of the equine head region is indicated in cases where clinical and radiographic examinations are inconclusive, when the exact localisation and extension of a lesion is needed for targeted therapy planning (Annear et al. 2008) and also to monitor cases with ongoing disease following treatment. Computed tomography has proven to be very useful in the diagnosis of fractures, dental disease, infection and neoplasia of the equine paranasal sinuses. General anaesthesia is usually required for equine CT examinations, but more recently some clinics offer CT examination on sedated, standing horses (Nelson 2008).

Differentiation of equine dental and periodontal tissues

A major advantage of CT is that the complex anatomy of the hard dental tissues and pulp system can be clearly differentiated. The peripheral layer of cement is hypodense compared to adjacent enamel. The hypodense zone of peripheral enamel extends from the clinical crown towards the apical region. Dentine is less radiodense than enamel and surrounds the hypodense pulp cavities (Puchalski 2006) which can be followed over their length. A column of dense secondary dentine lies over each pulp canal at the occlusal surface of healthy teeth. The infundibulae (rostral and caudal) are clearly seen in the maxillary cheek teeth. The hypodense central infundibular vascular channel must not be mistaken for an infected pulp with gas inclusions! The periodontal ligament appears as a narrow soft-tissue structure that separates the tooth from the surrounding alveolar bone. In healthy teeth a thin bony layer (lamina dura denta) lines the alveolus. Several publications have described the CT anatomy of the equine head (Tietje et al. 1996; Smallwood et al. 2002; Solano and Brawer 2004; Probst et al. 2005; Nöller et al. 2007; Rodríguez et al. 2008), including a recent study that described equine CT dental anatomy in detail (Windley et al. 2009a,b).

Advantages and limits of CT-diagnosis

Apical infection

Characteristic features are hypodense widening of the apical periodontium, sclerosis and deformation or disintegration of the apical dental lamina. Thickening of the overlying periapical soft tissue (granuloma formation) with or without gas inclusions, are also frequently encountered. Changes of the calcified dental tissues, in particular deformation or fragmentation of the tooth roots, occur in long standing cases (Puchalski 2006). In some chronic cases, considerable amounts of cement are deposited irregularly around the apex.

Pulpitis and pulp necrosis

Hypodense (black) areas indicating the presence of gas within the pulp or root canals are indicative of pulp necrosis. While the presence of gas inclusions facilitates the diagnosis of pulp necrosis in chronic cases, acute pulpitis is difficult to diagnose on CT images. Only subtle changes might be visible on CT slides which can easily be overlooked.

Dental fractures

Dental fractures are sometimes difficult to diagnose radiographically but they are readily detected on CT images. It is also possible to distinguish between single and multiple pulp cavity involvement (Bienert and Bartmann 2008). However, in some acute cases of dental fractures involving pulp cavities, no signs of pulp reactions are detectable on CT. This might be due to a process of healing by means of production of tertiary dentine or, alternatively, the horse might not have developed visible signs of pulpitis and subsequent periapical infection at the time of CT examination. In the latter type of cases, magnetic resonance imaging (MRI) has been described as a helpful diagnostic tool in the detection of periodontal disease, pulpitis or pulp necrosis (Gerlach and Gerhards 2008a,b).

Infundibular cemental hypoplasia/caries

Wide and air-filled irregular cavities are frequently seen on CT images of clinically normal infundibulae (Puchalski 2006). Although easily diagnosed, infundibular changes are frequently present in horses that do not show any clinical symptoms. In these cases dental extraction is not indicated. The diagnosis of severe infundibular caries penetrating the infundibular enamel is possible using CT examination and is of great help when deciding whether to extract or preserve a maxillary cheek tooth.

Periodontal disease

Signs of periodontal disease range from mild, focal changes (widening of the periodontal space, irregularities in the lamina dura denta, sclerosis, disruption and food and gas pocketing) to excessive destruction of the supporting maxillary or mandibular bones. The exclusion of periodontal disease is a prerequisite for endodontic therapy.

Sinus diseases

Sinusitis is common in horses and can be of primary origin or secondary to dental disease, trauma, cystic lesions, mycotic
infections or neoplasia (Feige et al. 2000; Puchalski 2006; Nelson 2008). One of the first signs of sinus disease detectable on CT imaging is a focal or diffuse swelling of the sinus mucosa. A varying degree of fluid accumulation or areas of increased density due to inspissated material can also be seen. In cases where the sinuses are entirely fluid-filled, the sinus mucosa will be indistinguishable from the surrounding fluid. In these cases evacuation of sinus exudates prior to CT examination may facilitate evaluation of the extent of mucosal swelling. In long standing cases, chronic distortion of the sinuses with exudate can cause deviation of the nasal septum, the facial bones and even dental apices. Chronic sinusitis may also cause thickening, endosteal sclerosis and an irregular periosteal reaction of maxillary (Puchalski 2006) and mandibular bone and new bone formation may be present along the internal and external supporting bony surfaces.

The presence of facial swelling and draining sinus tracts are some of the most common indications for referral of equine patients. Dental disease, dentigerous cysts (heterotopic polyodontia), head trauma, osteomyelitis and infrequently neoplasms account for majority of cases with facial swelling and draining sinus tracts. In most of these cases a definite diagnosis can be obtained radiographically; however, CT can be helpful in the examination of more difficult cases.

Tumours, neoplastic diseases

Despite the fact that a specific tumour classification is not possible using CT, the extent and grade of destruction of hard and soft tissues can be clearly evaluated, which enables a more accurate possible treatment plan and prognosis to be given.

Therapy planning, case monitoring

In complicated cases of ongoing dental-related disease, a CT examination can be very helpful in the detection of the lesion and planning of subsequent treatment strategies of oronasal fistulae or sequestrations secondary to tooth root remnants, bone necrosis or ongoing osteomyelitis.

References


Horses can acquire cheek teeth (CT) fractures through many mechanisms, including external trauma, e.g. as a result of kicks, and these traumatic fractures mainly affect the anatomically more susceptible rostral mandibular CT. Fractures to CT can also be caused by iatrogenic trauma during dental treatments, such as cutting tall CT overgrowths with dental ‘shears’. Horses with severe peripheral caries of CT can develop fractures of the peripheral enamel, but also through pulp chambers. However, most horses with CT fractures have no history or evidence of trauma or peripheral caries and such fractures have been termed ‘idiopathic CT fractures’ (Dacre et al. 2007). These fractures involve maxillary CT in about 80% of cases, and the Triadan 09s are preferentially affected (Taylor and Dixon 2007; Dixon et al. 2007). The exact prevalence of these fractures is unknown but a practice-based survey showed 0.4% of horses to be affected, with much higher levels detected by certain operators.

The aetiopathogenesis of idiopathic CT fractures is usually unclear, apart from midline sagittal infundibular fractures where the fractures appear to develop secondary to severe infundibular caries and perhaps infundibular fractures should now be removed from this classification. About 25% of teeth with idiopathic fractures have reduced thickness of secondary dentine, indicating long-term disease (or death) of some or all of their pulp horns that probably predispose these teeth to develop fractures, but no predispositions have been identified for most. The fractures run through the anatomically weakest part of the tooth, i.e. the pulp horns, or in maxillary CT with infundibular caries, sagittally through both infundibula.

The most common sites of idiopathic fractures are through the 2 lateral pulp chambers (pulps Nos. 1 and 2) of maxillary CT in what are termed ‘lateral slab fractures’ (Fig 1). Midline sagittal infundibular fractures of maxillary CT are as noted, a very common pattern. A variety of other less common fracture patterns can also occur in maxillary CT, involving one or more pulp chambers (Fig 1). Mandibular CT fractures (Fig 2), most commonly involve the 2 lateral pulp chambers, that have recently been renumbered as pulps Nos. 1 and 2 (du Toit et al. 2008). These 2 pulp chambers are more centrally located in mandibular CT and thus these fractures are sometimes erroneously described as midline sagittal fractures. Whilst lateral fractures of maxillary CT often only involve the clinical (erupted) crown, this pattern of fracture in mandibular CT often extends the full depth of the tooth (similar to infundibular fractures) and hence usually leads to eventual loss of the tooth. Almost all idiopathic CT fractures are sagittal in direction; occasionally these fractures will be oblique, but they never are in the transverse plane.

Many horses with idiopathic fractures are asymptomatic once a smaller fragment has been lost, provided the remainder of the tooth is not loose and does not have an apical infection or significant periodontal infection. In symptomatic horses with idiopathic CT fractures, quidding is the most common clinical sign and is usually due to oral pain caused by movement of the fractured tooth that abnormally stretches the periodontal ligament or to a displaced fragment (the displacement often caused by food impaction in the fracture site) causing soft tissue (cheek or tongue) injury. Biting and behavioural problems can occur, especially with displaced fracture fragments, and halitosis may also be present.

Dental pulps are inevitably involved in all (maxillary and mandibular) idiopathic fractures, including with the smaller maxillary CT ‘slab’ fractures. However, lateral slab fractures in particular, have been shown to clinically resolve without development of clinical apical infections, indicating that the resultant pulpitis remained localised or that the underlying pulp has been sealed off from the fracture site by deposition of tertiary dentine. Many such apparently viable teeth will have radiographic apical changes.
A proportion of fractured CT, especially maxillary midline sagittal fractures and mandibular CT fractures, will develop pulpar infection that extends to clinically affect the apex, with the resultant clinical signs dependant on which tooth is involved and such CT require dental extraction, per os if possible. If apical infection is not present, the fractured tooth does not necessarily need to be removed, but loose, usually smaller, dental fragments should be extracted and the remaining pulps checked for the presence of pulpar exposure. Protruding areas on the 2 adjacent CT should be reduced at 6 monthly intervals and the fractured tooth re-assessed at that time. Prevention of dental fractures secondary to infundibular caries has been attempted (especially in horses with pre-existing CT fractures) by removal of carious infundibular cementum and filling the infundibular defect with endodontic restorative materials, but objective research on this treatment is lacking.

References
The management of diastema and periodontal disease

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Most aged horses and ponies have some dental disease and the degree of dysfunction and abnormalities present can be dramatic. Regular dental care is essential for aged horses and failure to attend to dentition leads to a failure to maintain weight especially during the winter months. Prior to evaluating the oral cavity, an accurate medical history should be obtained because many of the aged horses presented for correction of dental abnormalities may have co-existing medical complaints. In addition, it is essential to obtain information on previous dental care, diet, appetite and the presence of halitosis or quidding. Examination of the oral cavity should be performed using a powerful light source, a full mouth speculum, dental mirror and with sedation at an early stage if the horse displays any sign of resentment.

Dental pathology: diastema and periodontitis

The denition of the horse has evolved such that in normally erupted cheek teeth (comprising the premolars and molars) no space exists between adjacent teeth. This enables all 6 teeth in the row (or arcade) to function as a single masticatory unit. Any diastemata between these teeth are considered to be pathological changes and can predispose to subsequent food entrapment between the teeth with subsequent gingivitis and periodontitis. A transient self-resolving periodontitis may occur during permanent cheek teeth eruption. Periodontal disease is most common in the older horse and is usually secondary to food-pocketing around the gingival sulcus. This may be as a consequence of diastemata, dental displacements, supernumerary cheek teeth or shearmouth/sawmouth. Chronic periodontal disease will result in progressively deeper periodontal membrane destruction and eventual tooth loss, especially in older horses. Presenting signs include halitosis, quidding, abnormal ‘slurping’ sounds during mastication, food pocketing between teeth and eventually loosening and loss of the teeth. Facial and mandibular swellings or discharging tracts are not a feature of this condition, even with deep-seated alveolar infections because the infection drains along the periodontal space into the oral cavity. Periodontal disease is very common, poorly recognised and results in significant discomfort.

Pathological diastemata are a frequently observed condition, especially in ponies and aged horses. In normal dental eruption the angulation of the 1st and especially 6th cheek teeth maintains compression of the interdental space along the arcade, preventing the existence of diastemata. In younger animals with erupting and recently erupted cheek teeth with large reserve crowns, the diastema usually result from maleruption of teeth resulting in dental displacement and misalignment. Such maleruption allows incomplete aposition of the rostral and caudal clinical crowns on the teeth, and subsequent entrapment of long-fibred food material between the teeth. Such maleruptions appear to be the result of overcrowding in pony breeds and miniature horses, due to the jaw length being relatively insufficient for normal eruption of the whole row. In such cases the maleruption and misalignment are often bilateral symmetrical and often lead to bilateral lingual displacement of the 4th mandibular cheek teeth (Triadan 109, 209) and buccal displacement of the 5th cheek teeth (310, 410). However, the direction of displacement does not always follow this pattern and there is wide breed and individual variation. Maleruption and displacement appears to be less common in the maxillary arcades, although the reasons for this are unclear. With advancing age the occlusal surfaces are worn by abrasion during mastication and the reserve crowns are shallower as the teeth erupt resulting in a reduced area of periodontal attachment of the reserve crowns and less compression of the interdental spaces from rostral to caudal along the arcade.

Periodontal disease

Most geriatric horses will have a degree of periodontal disease. Periodontal lesions start in the interproximal (interdental) areas of the teeth and the caudal mandibular spaces are most affected. The incidence of periodontal disease changes with age. A 40% prevalence has been reported in horses 3–5 years of age, this fell in horses 5–10 years of age and then increased to 60% in horses over the age of 15 years. Gingival hyperaemia, oedema, ulceration, deepening periodontal pockets and packing of feed material into these spaces are the classic pictures of periodontal disease. The presence of diastema enables food entrapment and its subsequent degradation which results in gingivitis. In contrast to the situation in humans the bacterial periodontitis/gingivitis syndrome appears to be extremely painful in horses where it has reached an advanced stage. There may be both supra- and subgingival plaque and calculus deposits associated with these lesions.

Periodontal disease in the horse has been divided into 4 categories based on evaluation of the severity of the lesion:

1. Local gingivitis with hyperaemia and oedema
2. Erosion of gingival margin 5 mm and periodontal pocket
3. Periodontitis with loss of gum
4. Gross periodontal pocketing, lysis of alveolar bone, loosening of bone support

Horses with low-grade periodontal disease may not show signs of oral pain. The observant owner may notice some excess salivation and sensitivity to cold water, or slow eating. Halitosis is a pathognomonic sign for severe periodontal disease in the horse and for this reason the use of disposable gloves is recommended when examining the oral cavity of the horse.

Routine dental care aims to preserve the health of periodontal structures. It is therefore not surprising that abnormalities of wear associated with tooth eruptions in young horses and arcade irregularities in older horses are the most common initiating factors in the pathogenesis of periodontal disease in the horse. Detection of periodontal changes and dental procedures to prevent deterioration may be particularly important in preventing or delaying chronic, irreversible changes.

Other factors influence the development and progression of periodontal disease and it is commonly described as being a multifactorial infection. Some of these factors include plaque, oral microflora and calculus, as well as age, general health, chewing patterns, breed, immune status and local irritants (e.g. grass awns).

Periodontitis can result in the production of excess cementum over the surface of the reserve crown - in some cases, progressing to a form of hypercementosis and the production of nodules of
Horses with concurrent systemic disease such as hyperadrenocorticism can frequently have advanced refractory periodontitis.

Prevention of periodontal disease is preferable to attempted treatment. Once advanced gum recession and loss of periodontal contact has occurred, reversal is not possible. Consequently, the equine clinician’s role is to eliminate irregularities of wear, oral ulcers and other conditions that may initiate the progressive process of periodontal pathology. However, there are currently few studies validating the efficacy of treatments for periodontal disease.

In horses with major irregularities of wear and advanced periodontal pocketing, treatment is aimed at restoring approximately normal occlusion. Digitally loose teeth should be extracted, since they have no functional purpose. In the management of cases with large diastema and periodontal disease the use of systemic antibiotics and local packing with antimicrobial eluting materials (Doxyrobe Gel, Pharmacia and Upjohn, Kalamazoo, Michigan) has also been advocated. More recently, widening of the diastema using a right-angled burr has been successful in selected cases although excessive removal of dental disuse will expose pulp and lead to caries. This treatment is most applicable to valve type diastema where there is tight occlusal contact obscuring deep periodontal cavitation.

Debridement of periodontal pockets in combination with topical and systemic antibiotics may enable the periodontium to partially heal in some cases resulting in a shallower periodontal pocket with a significant reduction in pain. Once debrided such pockets can be protected with temporary synthetic stenting material to prevent ongoing food impaction. This treatment is anecdotally effective but to date controlled studies are lacking.

Although periodontal disease affects the cheek teeth most commonly, the incisors can also be affected, although these teeth rarely become so diseased as to need extracting. Incisor diastemata are usually not associated with severe clinical signs but they can be enlarged using a diastema burr and this prevents build up of food material. However, daily brushing (with a soft nail brush, for example) of the incisors is easy to perform and can become a part of the animal’s daily grooming routine.

Further reading
Incisor lesions: equine odontoclastic tooth resorption and hypercementosis

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A painful and destructive dental disease, preferentially affecting incisors, has been increasingly recognized in aged horses during the last years. Clinical examination reveals incisor mobility, displacement, oral pain, gingival swelling and gingivitis which are occasionally associated with ulcerations and draining tracks with purulent discharge. Radiographs show substantial changes to the intra-alveolar aspects of the teeth and their surroundings, i.e. the periodontal space and alveolar bone. Although the radiographic appearance of the diseased teeth is not identical in all patients, there are 2 prominent radiographic findings which often occur in combination.

First, the intra-alveolar parts of the teeth are affected by substantial tooth destruction in terms of resorption of the calcified dental tissues. Second, the intra-alveolar parts of the teeth display a bulbous enlargement caused by radiopaque masses. Furthermore, loss of the periodontal space, disorganization of the alveolar bone and tooth fractures are frequent radiographic findings. Clinical reports indicate a progressive course of the disease with extraction of the affected teeth being the treatment of choice.

Until now, neither a plausible pathogenetic explanation for the described syndrome nor a tooth-preserving treatment has been presented. The purpose of the present study was to examine affected teeth in different stages of tooth resorption and hard substance hypertrophy to reveal the underlying pathological processes and aetiological factors. The results might also provide a basis for further studies addressing prophylactic procedures and tooth preserving therapies.

Specimens were obtained from 34 horses with characteristic symptoms (28 geldings, 6 mares, ranging in age from 12–35 years, mean age 20.5 years). 43 extracted teeth (39 incisors, 2 canines, 2 premolars) were cut into sections of approx. 10 mm in height using a diamond saw. Sectioned teeth were assessed using a dissection loupe (magnification 1.25-fold) in order to identify resorptive lesions, penetrations into the pulp cavity and presence of hypertrophic dental substances. Selected specimens were decalcified in 25% EDTA at pH 7.4 and 37°C (requiring between 2 and 4 weeks) and embedded in paraffin wax. Then, 3 micron serial sections were prepared. Alternate sections were grouped separately for different staining protocols and microscopic procedures. Examinations focused on the dental hard substances, the periodontal tissues and the dental pulp. Special attention was paid to detecting odontoclastic cells by means of tartrate resistant acid phosphatase (TRAP) staining.

A chronological sequence of tooth resorption followed by an excessive apposition of a calcified reparative tissue was demonstrated. Tooth resorption was mediated by odontoclasts; the reparative reaction was mediated by cementoblast-like cells producing an irregular type of cementum. The reparative process appeared to be unregulated causing massive hypercementosis. Consequently, the term EOTRH (equine odontoclastic tooth resorption and hypercementosis) was proposed for the described syndrome.

EOTRH shares many features with similar dental syndromes described in man (multiple idiopathic root resorption, MIRR) and cats (feline odontoclastic root resorption, FORL). However, studies on these diseases have shown that the predominant pathological factor is tooth resorption which is followed by moderate production of reparative, cementum-like tissue as soon as the sustaining stimulus for tooth resorption has vanished. The dimensions of newly formed cementum-like tissue described in the horse exceed those described in other species by far. In contrast to MIRR and FORL, there is evidence that the periodontal ligament of the horse is capable of reattaching to particular areas of the repaired tooth surface. This observation underlines the high capacity of the equine periodontal ligament for remodelling and regeneration.

An aetiological hypothesis proposes mechanical stress within the periodontal ligament as the initiating factor of EORTH. Alternative, aetiological explanations, including ischaemic necrosis, genetic linkage, systemic disorders such as Cushing’s syndrome, hypervitaminosis A, hypocalcaemia or hyperparathyroidism and idiopathic diseases, should be kept in consideration when performing further studies. Also a multifactorial genesis, including severe periodontal infections with particular pathogens, cannot be excluded.

Further reading
Diagnosing arrhythmias

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Introduction

Although cardiac disease is a rare primary cause of poor performance in the equine athlete, on the rare occasion that performance is affected by cardiac disease, dysrhythmia is the most common underlying cause.

The technique of taking a resting electrocardiogram (ECG) using a base-apex lead configuration is now well established in equine practice; most equine practices being equipped with both the expertise and technology to perform the task. Whilst the method can be valuable in confirming a diagnosis of sustained arrhythmias, like atrial fibrillation, or to diagnose the origin of premature beats heard at auscultation, a resting ECG usually offers little to the client in establishing a prognosis for future use of their horse.

The limitations of a resting ECG arise because of the enormous cardiac reserve of the horse, which means that performance-limiting cardiac disease and many abnormal rhythms do not manifest themselves at rest. This is compounded by the fact that alterations in resting cardiac rhythm are common in athletic horses because of normal high parasympathetic drive, yet some of these rhythms can also occur as a result of cardiac pathology. As a result, the effect of a resting arrhythmia on performance, or the effect of exercise on an arrhythmia, can only be established if an ECG can be taken during strenuous exercise when sympathetic tone and myocardial oxygen demand are increased and parasympathetic influence is reduced.

In the past, exercising ECG examination, although well described in the equine literature, was restricted to the specialist cardiologist, or the performance laboratory, largely due to the very high cost of radio-telemetric ECG equipment. However, the newest technology, based on palm and laptop computers, or specialised battery-operated devices, has become increasingly affordable for equine practitioners in Europe and this equipment has rapidly become the gold standard. This presentation will detail the methods, indications and likely diagnostic yield of electrocardiography in commonly encountered clinical scenarios in equine practice.

How much exercise should be used?

The type of exercise selected will vary depending upon the function and fitness of the horse, but in general every attempt should be made to replicate, or slightly exceed the intensity of the horse’s normal activity.

Horses not suitable for exercising ECG examination include those in which there are clear physical signs of cardiac failure at rest (tachycardia, tachypnoea, dependent oedema, etc.), horses with bacterial endocarditis, horses with sepsis, those with low-grade murmurs of mitral and tricuspid valve regurgitation or with functional murmurs, for whom the procedure is unnecessary. Also, horses that are not used for, or retired from, ridden work and those affected by concurrent lameness, or other problems that preclude fast exercise.

The conditions in which the technique is indicated are summarised below.

Horses with disappointing training or racing performance

The procedure is used to elucidate whether exercise-induced arrhythmias, such as paroxysmal atrial fibrillation; a condition with relatively high prevalence in racing Thoroughbreds, is present and to assess whether heart rate response to exercise is appropriate. More often than not, the technique allows the heart to be ruled out as a cause for poor performance and allows other avenues of investigation to be followed.

Horses with diastolic murmurs of aortic valve regurgitation

An exercising ECG is always performed alongside echocardiography to ensure that ventricular premature beats are not present during normal exercise and that the affected horse is not at an increased likelihood of collapse and sudden death. This increased risk can be present in affected horses long before the onset of clinical signs of heart failure, or negative effects on performance are detected by the rider. As a result, regular exercising ECG examination is mandatory in this group of patients, if they continue to be ridden.

To assess the effect of exercise on an abnormal rhythm at rest

This allows the horse’s suitability for ridden work to be determined.

Assessment of horses with sustained atrial fibrillation (AF)

Conversion of atrial fibrillation to normal sinus rhythm is not always indicated in pleasure horses. However, before making this decision, it is important to ensure that their heart rate response to normal exercise is acceptable and that they do not suffer from uncontrolled supraventricular tachycardia (SVT), or other malignant ventricular rhythms during exercise. This step is crucial to ensure that any horse with AF is safe to continue in ridden work without treatment, or to retire to lower levels of work, if treatment has failed.

Assessment of horses affected by moderate-severe murmurs of mitral and tricuspid valve regurgitation

In these cases, the ECG procedure ensures that affected horses’ heart rate response to exercise is normal and that abnormal rhythms do not develop during exercise.

Conclusions

Given that the horse is endowed with a large cardiac reserve, evaluation of the equine cardiovascular system and
electrocardiography (ECG) at rest only provide limited information, so that an ECG during exercise is an integral tool in the clinical evaluation of horses presented for episodes of exercise associated collapse, decreased exercise tolerance, poor athletic performance, or cardiac murmurs. Recent technological advances now allow this technique to be easily performed in equine practice and the new digital devices are ideally suited to performing resting ECG and longer term monitoring.

Further reading

NOTES
Atrial fibrillation (AF) is the most common atrial arrhythmia associated with poor performance in horses (Bonagura et al. 2010). The majority of horses with sustained AF have no evidence of significant structural heart disease, but ultrastructural and functional myocardial pathology, including AF-induced atrial remodelling, may still be present, predisposing to AF (Schwarzwald et al. 2007a; De Clercq et al. 2008a). Early recognition and prompt treatment of AF are thought to be important to prevent irreversible AF-induced atrial remodelling.

Quinidine sulphate (with or without the addition of digoxin) has been used for the longest period of time and still represents the gold standard treatment for AF in horses, despite the fact that treatment can be complicated by a variety of severe adverse reactions (Reef 2003; Bonagura et al. 2010). An excellent prognosis for quinidine conversion (>95% conversion rate) may be given for horses with short-lasting AF (<4 months) without underlying structural heart disease (Reef et al. 1988, 1995). Recurrences affect approximately 25% of these horses. Acceleration of IVC and consequent atrial and ventricular rate control during quinidine treatment, resulting in rapid supraventricular tachycardia. Affected horses are usually treated with digoxin to slow the ventricular rate. However, digoxin has a delayed onset of action, a low toxic-to-therapeutic ratio and may fail to effectively control heart rate. Based on recent studies (Schwarzwald et al. 2005, 2007a), diltiazem is likely to be safe and might be more effective than digoxin for ventricular rate control during quinidine treatment, provided that blood pressures can be closely monitored (Bonagura et al. 2010). Clinical experience with the use of diltiazem is limited and doses should be carefully titrated to effect.

Quinidine is becoming more difficult to obtain in some countries, which is one of the reasons why other treatment options ought to be investigated. Amiodarone, administered as a constant rate infusion, is potentially effective, but the long duration of treatment and high costs currently limit the use for routine treatment of AF (De Clercq et al. 2006, 2007). Flecaïnide has been proposed for the treatment of acute AF (Ohmura et al. 2000), but i.v. treatment is ineffective in cases with chronic AF and may result in potentially dangerous ventricular arrhythmias (van Loo et al. 2004, Birettoni et al. 2007). Oral administration has demonstrated some success (Risberg and McGuirk 2006). Intravenous propafenone has recently been shown to be ineffective in horses with naturally occurring and pacing-induced AF, respectively (De Clercq et al. 2009). Like quinidine, all of these drugs can exert proarrhythmic effects, so the ECG must be carefully monitored from the first dose. Based on the current (limited) knowledge on their efficacy and safety, these agents are not generally recommended for routine treatment of AF in horses.

However, they may be considered in unresponsive cases or when quinidine and TVEC are unavailable.

Transvenous electrical cardioversion (TVEC) of AF has been used at a number of referral centres as either the primary method of treatment or for management of horses that do not respond to quinidine therapy or develop severe adverse reactions to the drug. TVEC is very effective, especially for AF of recent onset, but it requires special equipment and trained personnel. The procedure involves percutaneous placement of 2 electrode catheters through the jugular vein into the left pulmonary artery and right atrium, respectively, followed by delivery of electrical shocks under general anaesthesia (McGurrin et al. 2005a,b, 2008; De Clercq et al. 2008a). A conversion rate of over 98% was reported in horses with ‘lone AF’ (i.e. without underlying structural disease: McGurrin et al. 2008). Potential complications associated with TVEC are related to general anaesthesia or electrical shock, but their incidence appears to be quite low.

Both quinidine and TVEC are generally safe and effective treatments, but there has been no prospective study comparing the 2 methods in regards to efficacy and adverse effects. Horses with longer duration of AF, extensive atrial remodelling, or significant structural cardiac disease may be more difficult to convert to sinus rhythm using quinidine or TVEC and are more likely to have a higher recurrence rate independent of the treatment modality.

References
NOTES

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Atrial fibrillation (AF) is the most common dysrhythmia in man, and is associated with significant morbidity and mortality.

The most important prognostic problem associated with AF in man is the 5–6 times increased risk of cerebrovascular accident (CVA) it confers. The clinical priority in man is thus to risk-stratify those with AF for CVA and advise appropriate prophylaxis (currently either with aspirin or warfarin). No electrical treatment for AF has yet to show a reduced risk of CVA and it is interesting to speculate on the reasons why the burden of AF is not correlated with the risk of CVA.

The best electrical treatment for AF in man is still controversial. Human cardiologists are both blessed and cursed with a bewildering plethora of treatments. The rapid advance in research into AF and explosion of invasive cardiac electrophysiology has fuelled this problem.

The major current areas of controversy are the arguments over rate-vs. rhythm-control; new anti-arrhythmics and ablation of AF.

Sotalol, a beta-blocker with Class III effects at high dose, is still commonly used to prevent AF. However, by far the most commonly used antiarrhythmic is amiodarone, a very effective drug with serious long-term side effects. A new derivative of amiodarone, dronedarone, has a better safety profile in most patients and, for the first time, has been shown in one trial to reduce cardiovascular mortality (Hohnloser et al. 2009).

With respect to rhythm control, direct current cardioversion is still the most effective therapy. It is useful both in emergencies, and as a way of demonstrating the clinical benefit of sinus rhythm, but is not a useful long-term treatment.

The growth area in AF is now ablation. Ablation was first used successfully in the context of concomitant valvular surgery, with the introduction of the Cox maze (Maze) procedure in 1987 (Cox et al. 1991). In this, extensive linear lesions are created throughout both atria. The aim is to abolish the substrate for atrial macroreentry, which was felt to be crucial to the propagation of AF. The Maze procedure and its subsequent iterations was sufficiently successful that it sparked interest in minimally-invasive strategies to replicate this.

However, nonsurgical AF ablation on a model of substrate modification proved unsatisfactory. It was not as effective and the sheer amount of atrial ablation needed raised both important safety and theoretical concerns.

The breakthrough came from Michel Haïssaguerre in 1998 (Haïssaguerre et al. 1998), who found that AF was commonly initiated by pulmonary vein triggers and that electrical pulmonary vein isolation (PVI) is an effective way of preventing this. The concept of ablation to prevent initiation as opposed to propagation allowed catheter-based techniques to become viable, and there has been an international explosion in AF ablation since.

The reality, however, remains that most AF in man is not adequately treated by PVI alone. There remains much work to be done to extend the validity of AF ablation to the general population.

References
Assessing cardiac murmurs

Sophy A. Jesty
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Murmurs are due to turbulent blood flow, the variables of which are included in the Reynolds number:

\[ Re = \frac{\rho \times V \times D}{\eta} \]

where \( \rho \) = fluid density, \( V \) = fluid velocity, \( D \) = vessel diameter, and \( \eta \) = fluid viscosity.

As the Reynolds number (and turbulence) increases, a murmur becomes more likely. Murmurs can be physiological or due to 3 underlying pathologies: cardiac or vascular shunts, valve regurgitations and valve stenoses. Valve regurgitation refers to an inappropriate retrograde flow of blood through a valve less than fully closed. Stenosis refers to an inappropriate obstruction to antegrade flow through a valve less than fully open. Correct characterisation of murmurs will allow for an accurate working diagnosis in the large majority of cases. At the very least, characterisation should include intensity (grade), phase of the cardiac cycle and point of maximal intensity (PMI). The most common causes of murmurs in horses include degenerative valve disease, ventricular dilation leading to annular stretch, infective endocarditis or valvulitis and valvular dysplasia.

The 4 valves work in 2 pairs: the atioventricular valves (mitral and tricuspid) and semilunar valves (aortic and pulmonic). During systole, the atioventricular valves should be closed while the semilunar valves should be open; therefore systolic murmurs can be due to either atioventricular regurgitation or semilunar stenosis (the former is common, the latter is rare). During diastole, the atioventricular valves should be open while the semilunar valves should be closed; therefore diastolic murmurs can be due to either semilunar regurgitation or atioventricular stenosis (the former is common, the latter is rare). Based solely on prevalence, the following aetiologies should be considered for specific murmurs:

<table>
<thead>
<tr>
<th>Timing</th>
<th>Point of maximal intensity</th>
<th>Aetiology</th>
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<tbody>
<tr>
<td>Systolic</td>
<td>Tricuspid valve</td>
<td>Mitral regurgitation</td>
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<td>Ventricular septal defect</td>
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<tr>
<td>Systolic</td>
<td>Mitral or aortic valve</td>
<td>Mitral regurgitation</td>
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<td></td>
<td>Pulmonic valve</td>
<td>Physiological</td>
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<td></td>
<td>Aortic valve, tricuspid valve</td>
<td>Ventricular septal defect</td>
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<td></td>
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<td>Aortic regurgitation</td>
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Physiological flow murmurs can be systolic or diastolic and can have PMIs over any region. In my experience, the most common physiological murmur is a systolic murmur with a PMI over the pulmonic valve. Physiological flow murmurs should not be grade 3/6.

Estimates of prevalence of mitral regurgitation (MR) range from 3.5% in apparently healthy horses in work (Patteson and Cripps 1993) to 35% of horses presented for cardiac work-up (Marr 2010). Mitral regurgitation is most commonly caused by degenerative valve disease or valvulitis, annular stretching (often due to aortic regurgitation), or infective endocarditis. Factors associated with a poorer prognosis include significant left sided chamber dilation, pulmonary artery dilation, myocardial failure on echo, and ventricular arrhythmias (Marr 2010). Mitral regurgitation is the most likely regurgitation to be found in poor performers and in horses with congestive heart failure (Marr 2010). In one study of horses with MR and congestive heart failure, all horses had characteristic murmurs grade 3/6 (Reef et al. 1998).

Estimates of prevalence of aortic regurgitation (AR) range from 2.2% of healthy horses in work (Patteson and Cripps 1993) to 8.7% of a referral hospital population (Holmes 1987), to 16% of horses presented for cardiac work-up (Marr 2010) to 55% of horses aged >10 years presented for cardiac work-up (Marr 2010). Aortic regurgitation is most commonly caused by degenerative valve disease or infective endocarditis. The aortic valve is the most common valve to be affected by degenerative valve disease and, therefore, AR is the most common regurgitation found in older horses. Factors associated with a poorer prognosis include severe regurgitation on colour Doppler with a steep pressure half time, significant left ventricular dilation causing MR, and ventricular arrhythmias (Marr 2010). As AR becomes hemodynamically significant, the pulse pressure increases, so bounding pulses are an important finding on physical exam of a horse with AR. AR can result in left sided heart failure or sudden death due to malignant ventricular arrhythmias.

A murmur consistent with tricuspid regurgitation (TR) is heard in 9% of healthy horses in work (Patteson and Cripps 1993). The incidence increases in racehorses. Tricuspid regurgitation rarely, if ever, causes clinical signs without other contributing cardiac abnormalities. Tricuspid regurgitation is most commonly caused by degenerative valve disease, tricuspid valve dysplasia (Hall et al. 2010) and pulmonary hypertension. Severe TR can result in right sided congestive heart failure.

Murmurs of pulmonic regurgitation (PR) are extremely rare. If a murmur of PR is heard it warrants further work-up, since it can be associated with infective endocarditis or significant pulmonary hypertension.

Ventricular septal defects (VSDs) are the most common cardiac shunt documented in horses (Hall et al. 2010). In virtually all horses with VSDs, there are 2 systolic murmurs heard on auscultation (Reef 1995) (PMIs over the tricuspid and pulmonic valves). Diastolic murmurs are heard in ~20% of horses with VSDs; this represents aortic regurgitation. In approximately 50% of horses with VSDs the finding is incidental and many horses can compete successfully with the defect (Reef 1995). Exercise intolerance (~40%), stunted growth (~20%) and left sided congestive heart failure (~15%) are seen in horses with VSDs.

Other congenital cardiac defects are less common. Horses with complex congenital cardiac malformations (e.g. Tetralogy of Fallot) often have less prominent murmurs because the pressure gradients responsible for high velocity shunts are not maintained or present in these conditions.

References
Heart failure (HF) can result from a multitude of diseases including congenital cardiac defects and acquired valvular disease, myocardial disease, pericardial disease, disease of the large vessels or severe cardiac arrhythmias. Most often, HF develops gradually over time. However, acute onset of severe valvular regurgitation (e.g. chordal rupture, acute papillary muscle ischaemia, rupture of a valve leaflet), severe primary myocardial disease (e.g. acute myocarditis, ionophore toxicity, acute ischaemia/infarction), aortic root or pulmonary artery rupture, severe pericardial effusion (e.g. pericardial trauma, neoplasia, atrial or aortic rupture), or multiform ventricular tachycardia (often associated with severe myocardial disease) may result in sudden onset of acute congestive HF (associated with pulmonary oedema) or cardiogenic shock (characterised by low cardiac output, hypotension, peripheral vasoconstriction, oliguria or anuria, weakness and syncope), requiring immediate emergency treatment.

The emergency treatment of acute congestive heart failure usually aims at immediate preload reduction and symptomatic relief. First choice treatment includes intranasal oxygen and i.v. administration of frusemide, except for cases associated with cardiac tamponade and severe diastolic dysfunction (see below). Dobutamine can be administered as a constant rate infusion to provide acute inotropic support and to improve blood pressures. Afterload reduction should be considered in cases with acute, severe pericardial effusion and cardiac regurgitation using hydralazine or milrinone, provided that blood pressures can be monitored. After initial stabilisation, long-term therapy with frusemide, digoxin and potentially angiotensin-converting enzyme inhibitors can be started, but limited published experience is available for the latter agents.

Horses with suspected myocarditis may benefit from administration of frusemide, except for cases associated with cardiac tamponade and severe diastolic dysfunction because of its proarrhythmic effects and its effects on calcium loading of the cells, potentially worsening the severity of myocardial injury. Extrapericardial aortic root rupture usually results in sudden death. Intrapericardial rupture results in acute cardiac tamponade (i.e. with massive haemorrhage into the pericardial space) or intracardiac shunt (i.e. aorto-cardiac fistula). Junctional or ventricular arrhythmias are frequently observed. Clinical signs, course of the disease and emergency treatment depend on the extent of the aortic rupture, affected cardiac structures, shunt severity, myocardial function and the severity of arrhythmias. Afterload reduction may decrease the severity of intracardiac shunting, diuretics and positive inotropes may be required to reduce signs of congestion and improve myocardial function and antiarrhythmic treatment may be necessary to treat severe ventricular arrhythmias.

Cardiac tamponade (i.e. reduction in ventricular filling because of fluid accumulation within the pericardial sac) causes a decrease in cardiac output due to diastolic dysfunction, leading to tachycardia, right-sided congestion, hypotension and possibly cardiovascular collapse. Preload reduction is usually contraindicated in patients with tamponade, because an increased preload is required to compensate for the impaired ventricular filling and to maintain cardiac output. Instead, echocardiography-guided pericardiocentesis is the first-line treatment for horses with severe pericardial effusion. ECG monitoring is recommended for immediate detection of arrhythmias induced by the procedure. Intravenous administration of crystalloid fluids may be required for preload support. After initial stabilisation, therapy should be continued according to the primary cause of disease.

Cardiac arrhythmias are common in horses and rarely require immediate antiarrhythmic treatment. However, acute antiarrhythmic treatment may be necessary if arrhythmia is the primary cause or the triggering factor of HF. Thereby, electrophysiological and haemodynamic adverse effects of antiarrhythmic drugs need to be carefully weighed up against their potential benefits. Profound bradyarrhythmias or rapid tachyarrhythmias can be life threatening and necessitate immediate emergency treatment to restore cardiac pump function and avoid cardiovascular collapse or death. An ECG diagnosis is usually necessary to confirm the rhythm diagnosis, choose the appropriate treatment and monitor drug effects.

Life threatening bradyarrhythmias include advanced second-degree and third-degree AV block, leading to severe exercise intolerance and syncope. Emergency treatment consists of administration of vagolytic drugs (i.e. atropine or glycopyrrolate), sympathomimetic drugs (i.e. dobutamine), or placement of a temporary transvenous pacemaker. Definitive treatment of persistent complete heart block consists of implantation of a cardiac pacemaker.

Atrial fibrillation is common in horses but rarely requires emergency treatment. Occasionally, digoxin treatment may be necessary for ventricular rate control in cases with supraventricular arrhythmia (including atrial flutter and atrial fibrillation) and accelerated AV conduction. Immediate emergency treatment to restore cardiac pump function and avoid cardiovascular collapse or death. An ECG diagnosis is usually necessary to confirm the rhythm diagnosis, choose the appropriate treatment and monitor drug effects.

Severe electrolyte disturbances (e.g. potassium, magnesium, calcium) can also cause cardiac arrhythmias. Hyperkalaemia is seen in foals with uraemia and in adults with acute renal failure, or hyperkalaemic periodic paralysis. Bradycardia or ventricular tachycardia can be seen together with typical ECG changes. In the most severe cases, ventricular fibrillation and cardiac arrest may ensue. Urgent treatment is required if the serum potassium is ≥ 7 mmol/l or if hyperkalaemia is accompanied by ECG changes or clinical signs including muscle weakness or flaccid paralysis. Emergency treatment of severe hyperkalaemia includes management of the underlying disease and administration of crystalloid solutions, glucose and insulin. Inhaled salbutamol, in combination with i.v. glucose-and-insulin, has been shown to be effective in man for emergency treatment of severe
hyperkalaemia and may be considered in horses as well. Severe metabolic acidosis may be treated with sodium bicarbonate to help drive potassium intracellularly, but this treatment is considered outdated in human medicine. Peritoneal dialysis may be beneficial. Finally, i.v. calcium is used to treat life threatening arrhythmias associated with hyperkalaemia.

Generally, monitoring of clinical parameters, blood pressures, and heart rhythm is advised during management of acute cardiac cases to assess the clinical course and the effects of treatment. Therapy of acute cardiac conditions may result in short-term success, clinical stabilisation and symptomatic relief. However, long-term prognosis for horses in heart failure is usually guarded to poor, except for some potentially reversible disorders.

**Further reading**
Proceedings of the
49th British Equine Veterinary Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

BEVA Congress
British Equine Veterinary Association
7-10th September 2011 • Liverpool, UK

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Thursday 9th September 2010

Endocrinology
Chaired by Alex McSloy

14.00–14.25

Diagnosis and treatment of PPID and metabolic syndrome

Nicola Menzies-Gow
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Diagnosis of pituitary pars intermedia dysfunction
A diagnosis of PPID is based on:

Signalment
The average age is 19 years and horses <10 years are rarely affected. There is no breed or sex predilection, but ponies are more likely to be affected than horses.

Clinical signs
Hirsuitism is the commonest clinical sign, occurring in 55–80% of affected animals. Weight loss is seen in up to 90% of cases. Lethargy, hyperhidrosis, recurrent laminitis, increased susceptibility to infections and polyuria/polydipsia also occur.

Further diagnostic tests
Haematology may be normal or may reveal a stress leucogram. Biochemistry may be normal or may reveal hyperglycaemia and/or increased liver enzymes. However, these alterations are nonspecific. Hormone assays include measurement of:

1. Plasma cortisol
In PPID, plasma cortisol concentration may be normal or increased. However, normal horses have diurnal variations in plasma cortisol concentrations, with significantly higher concentrations in the morning. In addition, plasma cortisol concentration will increase in a normal animal due to stress e.g. due to pain from laminitis. Thus this should not be used to make a diagnosis.

2. Urinary cortisol:creatinine ratio
The ratio is generally higher in PPID (approx. 30) compared to normal horses (approx. 10). However, there is a large overlap between the 2 groups of animals rendering it an unreliable test.

3. Serum insulin
Serum insulin concentration may be normal or may be increased. In addition, normal ponies can be relatively insulin resistant and therefore have an increased serum insulin concentration and insulin concentrations are significantly affected by feeding and exercise. Thus this should not be used to make a diagnosis.

4. Plasma ACTH concentration
Plasma ACTH concentration may be increased in horses with PPID. It is useful as a screening test, but is not 100% diagnostic. It is significantly affected by season with false positives frequently occurring in autumn.

5. Dexamethasone suppression test (DST)
This test is based on the lack of suppression of plasma cortisol concentrations in horses with PPID 19–24 h after administration of dexamethasone. It was considered to be the ‘gold standard’ method of PPID diagnosis, as it was reported to have a sensitivity and specificity of 100%. However, recently it has been shown that this is a significant over-estimate. In addition, DST results vary with season with false positives occurring in autumn.

6. TRH stimulation test
This test is based on horses with PPID showing an increase in plasma cortisol concentration 30–90 min following i.v. TRH administration, whereas normal horses do not. False positives occur and when both TRH and DST tests are performed, conflicting results are obtained.

7. Combined dexamethasone suppression TRH stimulation test
This test is based on the fact that plasma cortisol concentration decreases in all horses 3 h after administration of dexamethasone. Thus, administration of TRH at this time makes the resulting increase in plasma cortisol concentration more pronounced. This is not any more sensitive or specific and is less practical than the overnight DST.

Treatment of PPID
The decision as to whether specific medical therapy is required depends on the clinical signs and their severity. For example hirsuitism can be managed through regular clipping of the horse and PU/PD can be managed by ensuring that there is always access to adequate amounts of water. Recurrent laminitis is the clinical sign that most frequently results in medical therapy being initiated. There are 3 types of drug available:

1. Dopamine agonists
Pergolide is reported to be effective in 65–80% of cases. The initial dose is 1–5 mg per os s.i.d., decreasing slowly at 4–6 week intervals to the lowest apparently clinically effective dose. Side effects include diarrhoea, depression, anorexia and colic.

2. Serotonin antagonists
Cyproheptadine (0.25 mg/kg bwt per os s.i.d.) is reported to be effective in 28–60% of cases.

3. Cortisol synthesis inhibitors
Trilostane will only reduce the clinical signs associated with excess cortisol concentrations. At a dose of 0.5–1.0 mg/kg bwt, it is reported to be effective in 80% of cases.

Diagnosis of equine metabolic syndrome
A diagnosis of EMS is based on:

1. Clinical signs
The clinical signs associated with EMS are obesity, abnormal fat distribution particularly affecting the tail head, crest, shoulders,
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prepucce, recurrent laminitis and infertility in mares. A diagnosis of EMS should be considered in any individual with appropriate clinical signs. Further diagnostic tests focus on the demonstration of insulin resistance.

2. **Hormone concentrations**
   The demonstration of hyperglycaemia and hyperinsulinaemia in the fasting (overnight) horse is strongly suggestive of insulin resistance.

3. **Dynamic testing: combined glucose-insulin test**
   The test involves administration of 150 mg/kg bwt 50% glucose immediately followed by 0.10 units/kg bwt regular insulin (Humulin R or Humulin S). Blood samples for glucose will be collected prior to administration of glucose, and then at 1, 5, 15, 25, 35, 45, 60, 75, 90, 105, 120, 135 and 150 min. Blood glucose concentrations should return to below the baseline value by 45 min in healthy animals.

4. **Rule of PPID**

**Treatment of EMS**

**Weight reduction**
   The most important aspect of feeding a horse with EMS is limitation of the soluble carbohydrate intake. Ideally, grain should be eliminated and the affected individual should be fed only 1.5–2% of the target bodyweight as hay. The hay should contain ≤10% sugar and starch combined and can be soaked for 16 h before feeding to reduce the soluble carbohydrate content. If an owner is compelled to feed something in addition to forage, 0.68 kg (1.5 lb) of the hay can be substituted with 0.45 kg (1 lb) of unmollassed sugar beet pulp. A general vitamin and mineral supplement can be used, but fat supplementation should be avoided as it worsens insulin resistance.

**Exercise**
   Exercise aids weight reduction and promotes glucose uptake and use by skeletal muscle through an insulin-independent route that persists for 24 h, thus improving the hyperglycaemia.

**Medical therapy**
   Metformin increases insulin sensitivity in peripheral tissues and inhibits hepatic glucose production. Results in horses have been mixed with no effect observed in improvement in insulin sensitivity in obese mares. However, positive results have been seen in ponies at a dose of 15 mg/kg bwt per os b.i.d. Recent work suggests bioavailability of metformin is low and the half life is very short so this may account for some of the discrepancy.
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14.25-14.50
Metabolic syndrome in humans - aetiology and treatment
Jeremy W. Tomlinson
Centre for Endocrinology, Diabetes & Metabolism, Institute of Biomedical Research (2nd floor, Room 230), School of Clinical and Experimental Medicine, University of Birmingham, Birmingham B15 2TH, UK.

The global epidemic of obesity and its associated complications has hastened the need with which we must understand both the patho-physiological process that contributes to its development, and also the urgency with which we need therapeutic solutions that offer clinically meaningful and sustained weight loss. Dysregulation of the hypothalamo-pituitary adrenal axis has been observed in patients with obesity and the metabolic syndrome; however, circulating cortisol levels are not elevated. At a tissue specific level, in liver, muscle and adipose tissue, active glucocorticoid, cortisol is regenerated from inactive cortisone by the enzyme 11β-Hydroxysteroid dehydrogenase type 1 (11β-HSD1) and is thus able to amplify local glucocorticoid action. Tissue-specific dysregulation of 11β-HSD1 has been proposed as a pathogenic mechanism in obesity and the metabolic syndrome. There is clear evidence as to the beneficial impact of exercise upon health, in particular cardiovascular health, in normal weight and obese individuals as well as those with type 2 diabetes. Exercise training is associated with decreased cardiovascular risk, less atherogenic lipid profiles, improvements in blood pressure and insulin sensitivity. Importantly, the decline in insulin sensitivity once exercise training is discontinued exemplifies the need for permanent lifestyle modification and regular exercise. Pharmacological approaches have become more limited in recent years with the demise of several anti-obesity medications, most recently sibutramine, due to increased nonfatal cardiovascular and cerebrovascular events. Orlistat is now the only available licensed anti-obesity therapy in the UK. However, new therapies are emerging fast, including the use of GLP-1 analogues, which in the context of the treatment of patients with type 2 diabetes are an exciting advance. Currently, selective 11β-HSD1 inhibitors are in development and data from rodent experiments and early clinical studies suggest that these may be beneficial in man. The field of anti-obesity medication is full of exciting prospects, yet the challenge remains to find efficacious, safe and well tolerated drugs that will serve as an important component of the holistic approach to weight management.

Further reading
The incidence of obesity in children and adults is rising and is a major health problem that is reaching epidemic proportions. Obesity increases the likelihood of developing a range of chronic diseases (e.g. type 2 diabetes, some cancers, osteoarthritis) and there is now a well established link between increased body mass index and disorders of the cardiovascular system, including coronary artery disease and hypertension. Cardiovascular homeostasis is critically dependent upon proper functioning of the vascular endothelium which expresses and/or releases a range of proteins/mediators in response to circulating or locally-produced stimuli in a tissue-specific manner. In unperturbed blood vessels the balance of expression of these molecules by endothelial cells ensures that an anti-inflammatory and anti-thrombotic state prevails under these conditions. Pathology tips this balance to favour inflammation and thrombosis, resulting in the development of vascular disorders, including atherosclerosis. Endothelial dysfunction can be triggered by chronic exposure to a range of circulating factors, with oxidised lipoproteins and pro-inflammatory cytokines (e.g. MCP-1, TNFα, IL-6) the most well studied. Through a number of complex intracellular signalling mechanisms these mediators stimulate increased adhesion molecule expression by endothelium, encouraging chemotaxis, adhesion and trans-endothelial migration of leucocyte subpopulations, and concomitantly suppress the release of other mediators (e.g. nitric oxide) that normally protect the vessel wall by actively limiting these events. Obesity is characterised by both hyperplasia and hypertrophy of adipocyte populations. Adipose tissue produces a large number of factors collectively known as adipokines (e.g. leptin) and is also a rich source of pro-inflammatory cytokines. Not surprisingly, circulating levels of a range of inflammatory proteins and mediators correlate well with increased body mass index and substantial evidence now supports a role for adipose tissue in driving a state of low grade systemic inflammation in obese individuals. This has direct consequences for endothelial function since fat-derived factors directly influence endothelial cells thus contributing to the development of endothelial dysfunction and directly influencing cardiovascular risk. A number of drugs, particularly the statins and metformin, are thought to provide cardiovascular benefit, at least in part, by limiting the pro-inflammatory actions of adipokines. Continued investigation of the molecular interplay between endothelial cells and circulating adipokines may ultimately reveal new strategies for limiting obesity-associated endothelial dysfunction and its cardiovascular consequences.
Vascular complications of obesity

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Department of Veterinary Clinical Sciences, Royal Veterinary College, Hawkshead Lane, North Mymms, Hertfordshire AL9 7TA, UK.

Endothelial dysfunction

Endothelial dysfunction comprises a number of functional alterations in the vascular endothelium, such as impaired vasodilation, angiogenesis and barrier function, inflammatory activation and increased plasma levels of endothelial products, all of which are generally associated with cardiovascular disease. In the human clinical context, endothelial dysfunction is regarded as an important and early factor in the pathogenesis of atherothrombosis and vascular complications of diabetes (types 1 and 2) and is associated with a number of traditional risk factors including hypercholesterolaemia, smoking, hypertension, diabetes mellitus and insulin resistance and, more recently, obesity. In the equine clinical context, endothelial dysfunction appears to play a role in the pathogenesis of laminitis.

A key feature of endothelial dysfunction is the inability of arteries and arterioles to dilate appropriately in response to stimuli. This limits the delivery of nutrients and hormones to the distal tissues. Two mechanisms play an important role. The first dominant mechanism is a decreased bioavailability of the potent vasodilator nitric oxide (NO). The bioavailability of NO is determined by a balance of NO production by endothelial nitric oxide synthase (eNOS) and reduction of active NO by quenching with, subsequently, the activation of numerous genes involved in inflammation. In particular, the cell adhesion molecules VCAM, ICAM-1 and E-selectin have drawn much attention as cell adhesion molecules (adipokines) that play a major role in the normal regulation of immune, metabolic and vascular physiology. Changes in the regulation of nutrient metabolism in obesity promote nutrient storage in adipose tissue. This change in nutrient metabolism and consequent expansion of the adipose tissue mass causes a pro-inflammatory state to develop in the adipose tissue. Inflammation in adipose tissue is probably initiated by the secretion of low amounts of tumour necrosis factor-α (TNFα), which stimulate preadipocytes to produce monocyte chemoattractant protein-1 (MCP-1) resulting in the recruitment of macrophages and subsequently a changed excretion profile. The secretion of a number adipokines that modulate vascular tone, nutritive blood flow, and insulin sensitivity such as nonesterified fatty acids (NEFAs), (TNFα), interleukin-6 (IL-6), angiotensinogen and plasminogen activator inhibitor type 1, is significantly increased. NEFA shift the balance of insulin’s vasoactive effects toward insulin-mediated vasoconstriction. TNFα has been proposed to reduce all of the following: endothelial NO production, insulin-stimulated glucose uptake, capillary recruitment and insulin-mediated vasodilation. Leptin is a vasodilator through endothelium-dependent and endothelium-independent mechanisms. Leptin and insulin, in a synergistic mechanism, have been shown to enhance NO production. In contrast to these vasodilator effects, leptin also increases sympathetic nerve activity and enhances ET-1 release from vascular endothelium. Paradoxically, circulating leptin levels are elevated in obesity, apparently contradicting the beneficial effects of leptin described above. In contrast, the production of adiponectin is diminished. Adiponectin has recently emerged as an adipose tissue-derived modulator of endothelial function; it increases NO production and activates endothelial cells which induces vasoconstriction.

Effect of obesity on endothelial function

Adipose tissue, which includes adipocytes, preadipocytes and macrophages, is now recognised as the largest endocrine organ in the body, secreting a large array of immunomodulatory molecules (adipokines) that play a major role in the normal regulation of immune, metabolic and vascular physiology. Changes in the regulation of nutrient metabolism in obesity promote nutrient storage in adipose tissue. This change in nutrient metabolism and consequent expansion of the adipose tissue mass causes a pro-inflammatory state to develop in the adipose tissue. Inflammation in adipose tissue is probably initiated by the secretion of low amounts of tumour necrosis factor-α (TNFα), which stimulate preadipocytes to produce monocyte chemoattractant protein-1 (MCP-1) resulting in the recruitment of macrophages and subsequently a changed excretion profile. The secretion of a number adipokines that modulate vascular tone, nutritive blood flow, and insulin sensitivity such as nonesterified fatty acids (NEFAs), (TNFα), interleukin-6 (IL-6), angiotensinogen and plasminogen activator inhibitor type 1, is significantly increased. NEFA shift the balance of insulin’s vasoactive effects toward insulin-mediated vasoconstriction. TNFα has been proposed to reduce all of the following: endothelial NO production, insulin-stimulated glucose uptake, capillary recruitment and insulin-mediated vasodilation. Leptin is a vasodilator through endothelium-dependent and endothelium-independent mechanisms. Leptin and insulin, in a synergistic mechanism, have been shown to enhance NO production. In contrast to these vasodilator effects, leptin also increases sympathetic nerve activity and enhances ET-1 release from vascular endothelium. Paradoxically, circulating leptin levels are elevated in obesity, apparently contradicting the beneficial effects of leptin described above. In contrast, the production of adiponectin is diminished. Adiponectin has recently emerged as an adipose tissue-derived modulator of endothelial function; it increases NO production in vascular endothelium. The overall result is a chronic low-grade inflammatory state and endothelial dysfunction.

Effect of obesity on insulin resistance

Obesity is also linked to insulin resistance (IR), which in turn can lead to endothelial dysfunction. Some of the adipokines antagonise the effects of insulin, resulting in IR. Normally, insulin can dilate arteries and arterioles by a receptor dependent stimulation of a pathway that involves eNOS and leads to the generation of NO. In addition, insulin is also able to cause rapid release of ET-1, which occurs via an alternative pathway. In insulin resistant states, the pathway leading to the activation of eNOS is inhibited, whereas the alternative pathway remains functional and may even be over stimulated. The resulting imbalance between the production of nitric oxide and secretion of ET-1 favours vasoconstriction, and also contributes to platelet activation and leukocyte adhesion to the vascular wall.
Proceedings of the 49th British Equine Veterinary Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

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‘How to’ interpret equine cervical radiographs and other imaging modalities

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Plain radiography of the cervical vertebrae can be used to assess the likelihood of cervical stenotic myelopathy in horses with spinal ataxia (Moore et al. 1994), but accurate assessment requires a precise lateral radiograph (Rush 1998), ensuring that the ventral prominences of the transverse processes are perfectly overlying each other. Radiographic obliquity results in indistinct margins of the ventral aspect of the vertebral canal and results in erroneous values for objective measurements. A thorough understanding of the 3 dimensional anatomy of the cervical vertebrae aids in interpretation (Withers et al. 2009).

Cervical radiographs should be evaluated subjectively and objectively. Subjective interpretation is based on examining for presence of 5 characteristic malformations of the cervical vertebrae that include (1) flare of the caudal ephiphysis of the vertebral body; (2) abnormal ossification of the articular processes; (3) subluxation/alignment between adjacent vertebrae; (4) extension of the vertebral dorsal lamina and (5) osteoarthritis of the articular processes. Estimating the significance of lesions identified through subjective interpretation can be hard and is based on the clinician’s experience and interpreting the balance of probability. For example, osteoarthritis of (especially the caudal) vertebral articular processes is recognised commonly in normal horses (Whitwell and Dyson 1987). Hence recognition of characteristic vertebral malformations is considered supportive in diagnosis at best (Papageorges et al. 1987). Oblique radiographs are helpful in certain circumstances (Withers et al. 2009).

Objective assessment of vertebral canal diameter is more accurate than subjective evaluation of vertebral malformation for identifying young horses affected by CSM but may lead to false negative diagnoses in older horses (Levine et al. 2007). Both inter- and intra-vertebral measurements are used. The sensitivity and specificity of the intra-vertebral sagittal ratio method is approximately 90% for vertebral sites between the third and seventh cervical vertebrae (Moore et al. 1994). In most normal horses, the sagittal ratio exceeds 52% from the third to sixth cervical vertebrae and 56% at the seventh cervical vertebrae in horses greater than 320 kg. The positive predictive value of such measurements is probably higher and the negative predictive value lower, in ataxic horses from countries where conflicting diagnoses (such as EPM) are not routinely encountered (i.e. false positives are less likely, but false negatives are more likely because the underlying prevalence of CSM in ataxic horses is higher). Similarly, the positive and negative predictive values of objective cervical radiographic measurements in the absence of ataxia (for example during prepurchase radiography) have not been evaluated, but false positives are likely to be more, and false negatives, less common, since the prevalence of CSM in this population will be much lower.

Some clinicians advocate use of ratiometric measurements that take into account the distance between adjacent vertebrae (inter-vertebral ratios) based on the rationale that most compressive lesions occur between, rather than within, the vertebral (Hahn et al. 2008). Particularly high quality radiographs are usually required for such measurements, but analysis suggests that this approach may be helpful in differentiating CSM from other conditions (Van Biervliet 2007). Further comparison of both methods in a large group of horses is needed based on a gold standard diagnosis established at post mortem examination, since myelography is problematic (see discussion below), although available post mortem material may be skewed towards severely affected horses, since these animals may more often be subjected to euthanasia.

Plain radiography is often considered sufficient to make a presumptive diagnosis of cervical compression without the need for further tests. In countries where EPM or other conflicting differential diagnoses are possibilities, many clinicians favour myelography for diagnosis. Unfortunately, for most inter-vertebral sites, myelography results in a high number of false positive and false negative results (van Biervliet et al. 2004). Myelography remains, however, a prerequisite if surgical intervention is considered a viable option on the basis of severity of signs and the owner’s wishes and expectations. This is because plain standing radiography does not definitively pinpoint the actual site of the compressive lesion(s) (Moore et al. 1994). Note that neck flexion and extension while under anaesthesia are contraindicated if there is evidence of compression on the initial neutral views. Ventrodorsal projections may be attempted in small or young animals, especially in the cranial neck and may demonstrate an asymmetric compressive lesion that might otherwise account for some false negative diagnoses in larger horses.

References
Thursday 9th September 2010

16.40–16.50
‘How to’ inject cervical vertebral facets, using ultrasound guidance

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A thorough understanding of cervical vertebral anatomy and the ultrasonographic appearance of the cervical vertebral facet joints is essential before attempting facet injections. This author recommends Berg et al. (2003), which has excellent images showing the location and appearance of the cervical facets.

Cervical facet joints are formed from the caudal articular process of the cranial vertebra and the cranial process of the caudal vertebra. The joint is the most dorso-lateral point of the vertebra, being approximately 4–6 cm dorsal to the palpable transverse processes, and sits at an angle of approximately 30–40° above horizontal.

Imaging the facet joints for injection is most effectively performed using a micro-convex or phased array probe (6–10 MHz, 4–8 cm depth), as the small footprint facilitates easy needle placement (Fig 1).

A 10 cm square area dorsal to the transverse process of the affected vertebra should be clipped with a No. 40 blade. A standardised approach to the ultrasound image aids interpretation - this author always positions the probe reference dorsal, with the screen reference to the right, and holds the probe in a transverse orientation. The probe is placed 8–10 cm dorsal to the palpable transverse process, angled slightly downwards and then moved ventrally until the joint margins are imaged. If vertebral body is imaged the probe should be moved cranially or caudally to image facet neck and then joint. Angling the probe in a slight cranial direction can aid identification of the joint space. The facet joint margins are seen as 2 crescent shaped hyperechoic contours which cast acoustic shadows, separated by an anechoic joint space. It is often possible to image deeper into the joint space. A reasonable degree of variation in ultrasonographic appearance occurs between horses and between individual facet joints. Small osteophytes can often be imaged, as can some lipping of the joint margins. Significant changes include proliferation of bone dorsally, multiple osteophytes and widening of the joint space.

Prior to injection the horse should be sedated (0.01 mg/kg bwt detomidine and 0.01 mg/kg bwt butorphanol) and pretreated with a NSAID (1 mg/kg bwt flunixin meglumine) to limit muscular discomfort from the procedure. The clipped area over the affected joint should then be prepared aseptically. The use of local anaesthetic is typically unrewarding as the location of needle entry will vary greatly with head position. The probe should be placed inside a sterile glove or probe cover that has been filled with a small amount of acoustic gel. The horse’s head is then held in a neutral position. An image of the affected joint is obtained, with the joint space positioned centrally within the scan image. The depth of the joint should be noted (typically about 4–5 cm). The probe is then held in a fixed position, and a 12.5 cm 18 gauge spinal needle is inserted approximately 1 cm dorsal to the probe, with its long axis parallel to the long access of the probe, at a downward angle that will cause the needle to cross the centre of the ultrasound image at the depth of the facet joint. The needle is then advanced towards and into the joint and is seen as a hyperechoic line on the ultrasound screen. Repositioning can be required and can initially be confusing (Fig 2).

With the standard image right is dorsal and left is ventral. The skin acts as a pivot: to move the tip of the needle dorsally, the hub should be moved ventrally and vice versa. Alternatively, a biopsy guide can be attached to the probe and the biopsy line on the ultrasound machine positioned so it transects the joint; however, if the horse moves excessively during needle placement the biopsy guide can prevent easy repositioning. Both techniques are equally accurate, with 89% injections being either intra-articular or intracapsular (Nielsen et al. 2003).

The needle will typically enter the joint margin easily, if not raising the head can open the joint space. No attempt should be made to advance the needle deeper as dural puncture could occur. Synovial fluid will occasionally flow spontaneously or can be aspirated. Injection should be easy and if resistance is felt the needle should be rotated or withdrawn 1–2 mm as the tip may be embedded in articular cartilage. Injection should be directly visualised as hyperechoic sparking within the joint space. Whilst communication between the left and right facets of a given articulation can occur, they should essentially be treated as separate joints and injected individually. This author uses either triamcinolone acetate when injecting 2 facet joints (16 mg max per horse - 8 mg/joint), or methyl-prednisolone acetate when injecting more (40 mg/joint).

The reader should be aware that an alternative technique exists, where the ventral margin of the facet is injected, with the needle positioned ventral to the probe, with the joint space...
appearing as a step like structure (Mattoon et al. 2004). This author does not recommend this technique for beginners, given the proximity to the dura and risk of dural injection or spinal cord trauma.

References and further reading


Diagnosing and treating dysphagia

Simon F. Peek

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Introduction

Dysphagia in either foals or mature horses is a clinical finding that encompasses a broad differential list. The complete inability to swallow feed material and/or water conveys acute consequences in terms of hydration status, and slower, more subacute to chronic sequelae with reference to body condition and weight loss. In neonatal foals the loss of the ability to swallow can rapidly result in not only dehydration but hypoglycaemia and for several of the more common causes of dysphagia in foals there is a concurrent concern for aspiration pneumonia. Although aspiration can accompany dysphagia in adults it is rarely as acutely and potentially life threatening as in foals. Clinically, the term dysphagia is often applied more broadly not only to the individual that cannot swallow, but also to encompass those that cannot eat, and for this presentation I will address both.

When presented with a horse that a client describes as being unable to eat or swallow it is important to establish through anamnesis and physical examination whether or not there is a neurogenic or neuromuscular inability to coordinate the complex sequence of events that move food and water from the lips, through the oral cavity and pharynx down on through the oesophagus to the stomach, or whether there is a physical or pain related reason as to why the horse cannot move material in the same manner. This distinction becomes important as one formulates a differential list and diagnostic plan.

Physical and pain related reasons for dysphagia

Physical examination of the mouth, tongue, pharynx and observation of the horse attempting to eat and/or drink are critical in the initial work-up of a reportedly dysphagic individual. Denial problems and buccal/lingual trauma will be familiar to equine veterinarians in aged horses but the occasional case of an oral foreign body, maxillary/mandibular trauma or pain on palpation of the temporomandibular joint may also be identified during thorough physical examination of the head. Drainage lymph nodes for the head and pharynx should be palpated routinely and enlargement taken most commonly as evidence for oropharyngeal infection or rarely neoplasia. Non-neurological oesophageal conditions are mainly limited to physical obstructions and if there is a suspicion of choke this is typically suggested by the anxiety that it induces, nasal and oral reflux of feed and saliva and readily confirmed by passage of a nasogastric tube or endoscopy. Oesophageal palpation in the cervical region rarely demonstrates the obstruction but is important for the identification of the diffuse cellulitis that accompanies cervical oesophageal rupture which carries a grave prognosis.

Neurological and neuromuscular reasons for dysphagia

Following the physical examination one may be able to rule out non-neurogenic reasons for dysphagia and can then move on to consider primary neurological and neuromuscular diseases. The list of these diseases includes primary guttural pouch diseases (principally due to the anatomic location of cranial nerves IX and X within the pouch) diffuse neurological conditions of the forebrain/brainstem (such as viral encephalitides, toxic neuropathies), neuromuscular conditions (such as botulism) and selective cranial nerve lesions outside of the guttural pouch affecting those nerves responsible for coordinating swallowing (such as polyneuritis equi, EPM). Grass sickness will of course be a primary consideration in European countries. Experience suggests that guttural pouch diseases represent a significant proportion of neurogenic dysphagia cases. Further diagnostic procedures may include guttural pouch endoscopy, imaging of the head and neck (x-ray, CT or MRI if available) and cerebrospinal fluid examination.

Dysphagia in the neonatal foal

It is worthwhile to consider dysphagia in the neonatal foal separately to adults, as the differential list is quite different. Whenever one is presented with a foal with nasal regurgitation of milk it is important to consider both congenital and acquired conditions. Congenital palate abnormalities are a well established reason for dysphagia from birth, but occasional vascular ring anomalies have also been documented as a cause. Palate abnormalities should be checked for and will be obvious on physical examination. In certain geographic regions selenium deficiency (nutritional myodegeneration) may be an important differential for dysphagia in a nursing foal, but this is usually accompanied by clinical and biochemical evidence of more widespread skeletal myopathy. Botulism in endemic areas can be a significant differential for dysphagia in older foals. We see 1–2 foals a year with congenital dysphagia in whom no explanation can be elucidated, although some of them have persistent dorsal displacement of the soft palate. Some of these acquire normal swallowing activity by weaning, but are assured some degree of aspiration pneumonia and poor thrift in the interim.

Treatment of dysphagia

Within the limitations of a proceedings article it is impossible to comprehensively cover all the therapies for the wide range of differentials encompassing dysphagia in adults or foals. There are excellent accounts of these in standard equine medicine texts. By and large the physical and morphological causes discussed in the first part of these proceedings carry a more favourable prognosis than most of the neurogenic causes, although some of the guttural pouch disorders can have successful resolution of their dysphagia following therapy of the primary disease. Unfortunately some primary guttural pouch disorders may not cause dysphagia at the time of diagnosis but may develop neurological deficits to include dysphagia during therapy. Clients should therefore be warned of this and advised of the signs to look for. Whenever treating dysphagia in a horse, especially foals, it is important to evaluate the individual for aspiration pneumonia and consider therapy with antibiotics. Whilst this is unnecessary in older horses with dental issues, it will be critical in the successful treatment of a foal with botulism for example.

Further reading


Characterisation and causes of ataxia

Ataxia is characterised by lack of co-ordination of muscle movements with irregular movement of the head, neck, trunk and/or limbs. It can be classified into 3 syndromes: cerebellar, vestibular or sensory (general proprioceptive). The latter term defines the situation where the ascending proprioceptive input is disrupted due to a lesion(s) in the spinal cord, brain stem or rarely the brain and, although not strictly accurate, the term ‘spinal ataxia’ is often preferred by clinicians. This is much the most common form of ataxia encountered in the horse. Paresis usually accompanies vestibular and sensory ataxia but it is not a feature of cerebellar dysfunction.

Cerebellar dysfunction is characterised by jerky, hypermetric gait, swinging head movements, head tremor and often defective menace responses. There is no weakness. It is not commonly seen in the UK but outbreaks of vestibulocerebellar dysfunction have occurred here in association with tremorgenic plants. Cerebellar dysfunction may be also associated with head trauma and form part of the constellation of signs in generalised brain disease. Cerebellar abiotrophy can also be familial in some breeds and congenital disorders affecting the cerebellum and other areas of the brain, such as Dandy Walker syndrome, have been reported in foals.

Vestibular dysfunction is characterised by loss of the mechanisms that orientate the head, eyes, trunk and limbs. Vestibulospinal tracts extend along the length of the spinal column and are facilitatory to ipsilateral extensor muscles and inhibitory to flexor muscles and a lesion on any given side tends to push the limbs towards the lesion. Equally, head tilt, a consistent sign of unilateral lesions, when considered as rotation around the poll, is usually toward the lesion. Nystagmus is common but often resolves quickly. It can be difficult to distinguish central from peripheral vestibular signs, but clues that the lesion may be central include additional accompanying cranial nerve signs, depression and limb weakness. Some afferent fibres from the inner ear travel through the cerebellum and there is proprioceptive input from the cranial cervical vertebrae and associated structures thus lesions in these areas, in addition to the inner ear, cranial nerve 8, medulla oblongata and vestibular nuclei in the brainstem, can lead to vestibular signs.

Spinal ataxia relates to the interruption of afferent proprioceptive information to the cerebellum which allows the animal unconsciously to locate its limbs and body and to the cerebral cortex for conscious proprioception. Abnormalities of gait consistent with spinal ataxia include unpredictability i.e. foot position and stride varying from stride to stride, pacing, excessive adduction particularly when turning and both hyperflexion and hypoflexion. One or more limbs are affected depending on the location and nature of the lesion. Upper motor weakness will often accompany spinal ataxia. Key questions are whether all 4 limbs are involved and whether both sides are affected symmetrically or asymmetrically. Note should be made of the degree of accompanying weakness and presence or absence of additional neurological signs such as muscle atrophy (suggesting concurrent lower motor neuron involvement), sensory deficits, loss of cervical and truncal reflexes and urinary or faecal incontinence. If brain disease is involved there will usually be additional signs such as alteration in mentation and cranial nerve signs. Careful and systematic neurological examination should allow the clinician to make a basic neuroanatomical assessment of the likely location of any pathology and this will help refine the list of differential diagnoses. In younger horses, cervical vertebral malformation is the most common cause of spinal ataxia and in horses of all ages, ascending, symmetrical spinal ataxia with weakness should immediately prompt the question ‘could this horse have paralytic herpes?’ A range of other conditions must be considered with severe spinal ataxia including vertebral fracture, head trauma, soft tissue trauma, cerebral arthrits, equine protozoal myeloencephalitis (EPM), viral meningoencephalitis, bacterial meningitis, atlantoaxial malformation, synovial cysts and neoplasia. Spinal ataxia can also be associated with toxins such as stinging nettles, fluphenazine and mioxidin.

Diagnostic approach and initial management in the severely ataxic horse in the emergency setting

Severely ataxic horses are challenging to work with, not least because their size limits our ability to help them. The first priority must be to restrain the horse safely, usually with sedation although ideally some attempt should be made to determine which form of ataxia is present and identify additional neurological signs before this is administered. In the most extreme cases, there is merit in considering general anaesthesia to facilitate transportation, preliminary treatment and to allow further diagnostic tests to be completed. If EHV1 is included on the differential list, serology, and virus isolation and PCR of nasal swabs, buffy coat and CSF should be submitted. Biosecurity procedures should be instituted without delay until EHV1 can be ruled out. Where signs of brain dysfunction are present, head radiographs, upper airway endoscopy and CSF analysis are indicated. Magnetic resonance imaging and computed tomography of the head can be useful where abnormal mentation and cranial nerves are present. Cervical radiography is generally the first tool used to characterise cervical disease although clearly it will only be abnormal if bone pathology is present. Nuclear scintigraphy allows the entire vertebral column to be assessed and may identify lesions that are radiographically silent. Early therapeutic goals will be influenced by the suspected or confirmed diagnosis but include analgesia, anti-inflammatories and anti-oxidants. Cefquinome is one of the more commonly available antimicrobials that will cross the blood-brain barrier. Ponazuril, nitazocanie or sulphadiazine/pyrimethamine should be given if EPM is suspected. Recumbent horses are challenging to manage for any length of time but can be achieved in a hospital setting with dedicated and experienced staff. The prognosis for many of the conditions listed above as possible causes of severe ataxia is guarded and the best prognostic indicator is often the initial response to treatment.

Further reading

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This paper will present an overview of the legal components of professional negligence in the veterinary sphere. Against that background the pattern and examples of recent equine claims handled by The Veterinary Defence Society will be discussed, in the context of lessons to be learned.
Medicinal treatment of horses is complicated by the status of the horse as a food animal across the EU. This brings the treatment of horses under close scrutiny to ensure horses intended for human consumption are free of unacceptable residues at the time of slaughter. The European Commission recognised that the range of veterinary medicinal products for horses could be improved and this has led to a raft of legislative adjustments to allow horses to be treated as food producing animals or to be excluded from the human food chain and made exempt from the typical controls on the use of food animal medicines. The EU Horse Passport regulations for example, permit horses to be excluded from the food chain as a result of a positive choice by the owner with ‘food animal’ as the default status. The European Commission also introduced legislation establishing a list of medicines that were considered essential for treatment of horses with the intent to improve the availability of medicines for this species. The Veterinary Medicines Regulations operate in parallel to the horse passport system and set out the legal provisions for the prescribing and supply of veterinary medicines. The cascade permits veterinary surgeons, under their own responsibility, to use medicines not authorised for use in horses, provided the requirements for treating food animals are observed where relevant and there is a clinical justification for prescribing an unauthorised medicine in preference to an authorised product.

Where a horse is to receive treatment as a food animal then legislation on maximum residue limits (MRL) for active ingredients will apply and only products containing substances that have an MRL may be used for therapy. Any product that is specifically authorised for a food producing species will meet these requirements but a suitable withdrawal period should be applied before a treated horse enters the food chain. The essential substances list permits the use of certain active ingredients to treat horses intended for human consumption where no MRL exists. In these cases, at least 6 months must be applied as a withdrawal period before the animal is slaughtered for human consumption.

Veterinary surgeons have a professional duty to use veterinary medicines responsibly and to ensure their horse owning clients are aware of behaviours that represent responsible use. It is the duty of the horse owner to ensure their horse, when entering the food chain, is free of unacceptable residues arising from any treatments used. Veterinary surgeons should ensure owners are instructed in the correct use of medicines and for using, storing and prescribing medicines in accordance with the Veterinary Medicines Regulations.

NOTES
SPVS encourages best business practice within the veterinary profession and at the heart of any business are the staff within it. Old attitudes of devoting all your time to the practice, at the expense of one’s health and family, are thankfully dying out. SPVS feels that it is incumbent on any employer to provide decent working conditions, regardless of legislation.

We would also like to emphasise that even with full compliance of WTRs, practices still have a duty under H&S legislation to ensure that staff are not tired whilst working. There are instances of staff being involved in road collisions resulting in injury to themselves or third parties. In these cases it would be normal for the police to examine the on-call rotas leading up to the incident.

The Working Time Regulations 1998 (amended 2003) are the basis of regulation. The basic rules for workers over 18 are

- Staff are entitled to 5.6 weeks holiday per year (4 weeks + statutory Bank Holidays)
- Staff must work no more than 6 days out of 7 (or 12 out of 14)
- Staff must take a 20 minute break if their shift lasts more than 6 hours
- Staff must work a maximum of 48 hours a week
- Staff must have a minimum of 11 hours rest between each working day

In general staff rotas to cover the ‘normal’ working day do not cause much of a problem.

It is the out of hours work which causes the problems for practices. Case law has decreed that workers on the premises, even if resting, are considered to be working whereas up until now those on call and off the premises are considered not working until they actually receive a call. Assuming the latter arrangement continues then it is realistic for a four-man practice to be able to make rota arrangements to ensure that, even with a busy night and weekend on call, it is very unlikely that any vet feels that it is incumbent on any employer to provide decent working conditions, regardless of legislation.

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However, it tends to be smaller practices which find these regulations impossible to come to terms with. Whilst the UK currently has a derogation for workers to ‘opt out’ and to volunteer to work more than 48 h, this is not guaranteed to continue and we would emphasise that it is voluntary. However many practices have such agreements in place with their workers.

It is also possible, under EU law, for workers to determine their own working conditions by negotiating a work force agreement. This is particularly applicable where staff spend time on the practice premises but are not expected to work continuously, i.e. they are on duty but can sleep when possible. In such a situation a workforce agreement can be used to agree that, for instance, the hours between 19.00 and midnight count as normal hours and then the hours between midnight and 08.00 are counted as 3 hours.

A working example of how this could be done in practice is provided.

- **Step 1:** a full practice meeting is arranged where a practice principal, partner or director explains what the WTR’s are and how they apply to the practice and lists possible options.
- **Step 2:** work force representatives are nominated and elected (without the employers present).
- **Step 3:** over a period of several weeks the representatives meet with the work force explaining the issues and seeking feedback. The same representatives meet with the employers to negotiate a universal consensus on each point.
- **Step 4:** those employees willing to do so, will sign an opt out agreement. It is a good idea to also agree the minimum notice period the staff have to give to resign from this opt out, maybe 2 months so as to minimise the disruption to out of hours rotas. Health and Safety considerations would override such an agreement.
- **Step 5:** the work force representatives sign up to the negotiated workforce agreement. This means that groups of workers may, if they wish, redefine ‘working’ and ‘rest’ time. For instance the staff may agree that nonworking, on-site OOH work may be regarded as rest time and that it need not be uninterrupted, provided that compensatory rest can be taken within a reasonable time. NB the work force agreement must be for a set period of time e.g. 3 years and must be re-negotiated at the end of that period.

<table>
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<tr>
<th>Table 1: Example of a rota where the vet is fulfilling normal duties for 4.5 days a week and is on call for one weekend in 4 plus one night a week</th>
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<td><strong>Week 1</strong></td>
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<td><strong>Total</strong></td>
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- **Average:** 48

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**Thursday 9th September 2010**

**09.20–09.40**

**EU Working hour regulations - what they mean for your Practice**

**Jacqui Molyneux**

Prince Bishop Veterinary Hospital, 1 Plantation St, Leadgate, Consett, Co Durham DH8 7PR UK.
Thursday 9th September 2010

We emphasise that this is an unknown area and that only case law will provide a definitive ruling. Regardless of personal interpretations of the WTR, practices must provide a considered risk assessment of the hours their staff are working. We would recommend that any agreements are assessed by solicitors specialising in employment law.

Further reading
www.hse.gov.uk
www.direct.gov.uk

NOTES
Mental wellbeing: results from the RCVS survey of the profession 2010

David Bartram
c/o Division of Clinical Neurosciences: Mental Health Group, School of Medicine, University of Southampton, RSH Hospital, Brintons Terrace, Southampton SO14 0YG, UK.

Internal construct validity of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS): a Rasch analysis using data from the RCVS Survey of the Profession 2010

Background
WEMWBS is a recent and psychometrically robust measure for assessing population positive mental health, comprising 14 positively phrased items which measure positive affect (i.e. hedonic aspects of well-being: feelings of optimism, cheerfulness, relaxation), psychological functioning (i.e. eudaimonic aspects of well-being: energy, clear thinking, self-acceptance, personal development, competence and autonomy) and interpersonal relationships (Tennant et al. 2007).

Veterinary surgeons are at high risk of suicide, with a proportional mortality ratio around 4 times that of the general population and approximately twice that of other healthcare professions (Bartram and Baldwin 2010). There has been much speculation regarding possible mechanisms underlying the increased suicide risk in the profession but little empirical research. The contribution of poor mental health and well-being to the elevated risk was assessed through a postal questionnaire survey (mailed in October/November 2007) of a large stratified random sample of 3200 veterinary surgeons practising in the UK: A cross-sectional study of mental health and well-being and their associations in the UK veterinary profession. Compared to published results for the general population, the sample reported high levels of anxiety and depressive symptoms; higher prevalence of suicidal thoughts; less favourable psychosocial working conditions, in regard to the high level of demands (work pace, volume and complexity) and low level of support from superiors and employers; lower levels of positive mental well-being; and higher levels of negative work-home interaction (Bartram et al. 2009).

In this survey, the WEMWBS score was associated with other standardised measures of mental health, showing a negative correlation with anxiety and depressive symptoms and a positive correlation with favourable psychosocial working conditions, supporting the validity of the scale as an overall indicator of population mental health and well-being for this occupational group (Bartram et al. 2010).

On the basis of these results, the RCVS incorporated the WEMWBS into its Survey of the Profession 2010 (administered by Institute of Employment Studies) in order that summary statistics for the scale may be used to monitor the mental well-being of the profession at a population level over successive years of the survey and inform the development of initiatives with potential to improve mental well-being (Bartram 2009).

An examination of the internal construct validity of WEMWBS from the perspective of the Rasch Measurement Model (Rasch 1960; Stewart-Brown et al. 2009) in the context of the veterinary surgeons and veterinary nurses will inform assessments of the suitability of the scale for future use within these occupational groups.

The internal construct validity of WEMWBS from the perspective of the Rasch measurement model in the context of veterinary surgeons is reported here.

Methods
The model was applied sequentially to data collected from 4 different groups of 500 respondents randomly selected from the 7837 veterinary surgeon respondents to the RCVS Survey of the Profession 2010 who completed all 14 items of the WEMWBS scale (36% response rate).

Results
Median WEMWBS score 50 (interquartile range, IQR 44–55). Median score for men (n = 3709) was higher than for women (n = 4104) (51 vs. 49; Mann-Whitney U test, P<0.001)

Initial fit to Rasch model expectations was poor. The items ‘I’ve been feeling good about myself’, ‘I’ve been interested in new things’ and ‘I’ve been feeling cheerful’ all showed significant misfit to model expectations and were deleted. This led to a marginal improvement in fit to the model. After further analysis, more items were deleted and a strict unidimensional 7 item scale (the Short Warwick Edinburgh Mental Well-Being Scale [SWEMWBS]) was resolved. Many items deleted because of misfit with model expectations showed considerable bias for gender.

Given fit to the Rasch model, and strict unidimensionality, SWEMWBS provides an interval scale estimate of mental well-being.

Conclusion
A short 7 item version of WEMWBS was found to satisfy the strict unidimensionality expectations of the Rasch model, and be largely free of bias. This scale, SWEMWBS, provides a raw score-interval scale transformation for use in parametric procedures. Transformed SWEMWBS scores are more appropriate measure to track changes in mental health in the veterinary profession than the scores from the full WEMWBS scale.

References
References available on request.
NOTES

Coping with nursing sick horses - when is enough enough?

James Yeates

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Sick horses may suffer a number of welfare compromises. These include physiological and pathological states such as injuries, dehydration, malnutrition and inflammatory and stress responses, and inabilities to perform motivated behaviours. These may correspond to various unpleasant mental states, which can be described as the ‘illness’ of disease, most notably malaise and pain, but also including boredom, fatigue and frustration.

The use of curative or palliative treatment protocols can improve horses’ QOL to certain levels. The same treatments may also be life-saving, by curing underlying diseases. In other cases, euthanasia or a high-risk treatment may end the animal’s life. But such treatments come with a risk of iatrogenic welfare harms. Surgical interventions may cause pain and hospitalisation may cause stress and frustrate motivated behaviours.

This paper firstly considers how improvements in quality-of-life can be maximised, and iatrogenic harms minimised, through the use of pain assessment tools, quality-of-life assessment methodologies and welfare-based care plans. For example, established quality-of-life assessment methods can be useful in many ways, including screening for issues that have not been noticed by an owner; monitoring chronic and progressive cases; assessing palliative treatment; monitoring geriatric cases; assessing iatrogenic side effects; assessing novel surgeries or treatment regimes; providing useful prognostic indicators; determining treatment priorities and in clinical governance and trials. These can be adapted and used in equine practice, although practitioners must decide other questions, such as who is best placed to monitor quality-of-life.

In some cases, this treatment can improve patients’ welfare to an acceptable level. This may be defined as being worth living, i.e. more enjoyable overall for the period of treatment than being nonexistent (a comparison with being anaesthetised can be a useful way of thinking about this).

But in other cases, the patient’s life is not worth living while it is under treatment. In these cases, life-saving treatments, while beneficial in one sense, risk perpetuating that suffering. Indeed, even palliative care that improves welfare can harmfully extend life if it delays an owner’s decision to opt for euthanasia. Indeed, keeping animals alive is effectively an iatrogenic harm caused by the practitioner. Conversely, euthanasia would end the suffering, but at the cost of any potential future life.

Practitioners need to assess and balance the welfare harms and benefits. Three approaches may be useful. One is to leave all decisions to the owner. This method has the advantage that owners know about their animals’ preferences and needs, because they spend considerable time with them. However, it also relies on owners’ understanding of the procedure, probabilities and biology.

A second approach is to try to balance the costs and benefits using welfare-based methods, such as multiplying the severity, duration, frequency and probability of predicted mental states given the different options available. The use of established quality-of-life assessment methods can be also useful in euthanasia decisions and decisions about life-saving treatment. This has the advantage of capturing all important welfare states, but makes for very complicated decisions, based on subjective assessments and probabilities. Furthermore, these decisions may be difficult to communicate to owners.

A third approach, which utilises similar underlying frameworks, is to consider the concept of Quality-Adjusted-Life-Years. These are used in human medicine, originally for resource allocation, but may be adapted for use in equine practice. The general idea is that each treatment is rated in terms of the longevity that it is expected to provide, adjusted (e.g. multiplied) by a measure of the overall quality-of-life during that period, usually with the quality of healthy life rated as ‘1’ and poorer quality lives as between 0 and 1. Death is effectively rated as zero. Medical assessments usually consider human life to always have positive value, but animal life could be scored as worth less than zero, which would indicate euthanasia. This approach can usefully take into account other contingent factors such as owners’ finances, compliance and realistic prognostics, as well as QOL assessment.

One final consideration is how to communicate these ideas to owners, and a model of joint-decision-making is sketched, which may improve concordance and lead to better patient outcomes.

References and further reading

Introduction
The ability to deal with people is even more important today with the pressures of our fast-paced environment. Being able to handle conflict in a productive way is frequently mentioned as one of the most challenging skills for people.

Overview
The presentation will reflect on your current approach of handling conflict, to enable awareness of the areas that need to be improved upon. Using effective conflict resolution strategies will help to foster a more cooperative environment.

Internal conflict resolution
Following these guidelines, you will be able to:
• Understand reactions to conflict in order to better manage attitudes.
• Analyse conflict situations to determine best approach to achieve desired outcomes.
• Develop conflict resolution strategies that foster teamwork.

Before embarking on conflict resolution, people need to understand whether they are ‘passive’, ‘assertive’ or ‘aggressive’ when dealing with conflict. In order to assist with this process, a conflict reaction profile questionnaire will be provided and discussed.

Strategies for reducing conflict
Manage work process conflicts:
• Ask yourself “How much control do I have over this work process?”
• Identify the root cause of the problem and analyse the improvement opportunity.
• Talk first to the owner of the work process.
• Describe the current problem and get agreement.
• Suggest a workable solution and action plan.
• Follow through with the plan and most importantly give recognition to the owner of the work process.

Role conflicts:
• Ask yourself, “Exactly how do I perceive and view my role in relation to others involved in this issue?”
• Take responsibility for clarifying your role with others involved.
• Be prepared to change your perception of your role.
• Show your willingness to be flexible in achieving the goals of your practice.
• Stay positive. View any role change in terms of the opportunities it presents.

Interpersonal conflicts:
• Ask yourself, “How much do my personal biases and prejudices affect this relationship?”
• Write down 3 behaviours that you could change in order to reduce conflict in this relationship. Commit to following through on these changes for at least 3 months.
• Ask the other person involved how you could defuse the existing conflict. Encourage feedback that might seem brutally honest.
• Put yourself in their position. How do you think they view your commitment to reducing conflict in your relationship? Why?
• Make a list of 5 strengths that you see in the other person. Then list 5 ways that improving this relationship would benefit you.

Direction conflicts:
• Ask yourself, “Am I clear on the direction or vision?”
• Clarify the discrepancy so that it can be easily described in neutral words and take action.
• Ask permission to address the discrepancy with the other person in a friendly nonconfrontational way and gain agreement.
• Use “I” and “we” messages rather than “you” messages.
• If there is a difference in values, always go with the higher value.
• Make authentic commitments.

External conflicts:
• Ask yourself “How much control do I have over this factor?”
• Choose to fight battles that are worth the cost.
• Put your energy into things you “can do” rather than complain about what you “can’t do”.
• Do something that is a win/win situation for others.
• Maintain perspective and sense of purpose.
• Talk to people you trust.

Once the best practice method of handling the specific conflict has been identified, it can be helpful to draw up a conflict resolution action plan. This would include specifying the conflict, the people involved, a plan of action, the results expected and who would be accountable.

“Don’t be afraid of opposition. Remember, a kite rises against, not with, the wind.”

Hamilton Wright Mabie
We need to support grieving owners with compassionate, empathic care which helps them to consider the various options, reassures them that it is normal to feel upset; and validates their informed decisions.

Why do we need to?

It is important for the emotional wellbeing of the owners and veterinary staff both in the short and longer term and will have ramifications in many aspects of their, and our, lives.

For children it may be their first real experience of attachment and loss.

Bereavement is the loss of someone or something that is valued and the grief that follows can be devastating. Often it is hard to recognise the extent of the human-animal bond (HAB) that exists until there is loss and separation. For the owner, the reaction that they experience when they lose their horse can be very shocking, with the true extent hidden to everyone but themselves.

For others around them, it can appear out of proportion and inappropriate and it can be very difficult to know what to do or say.

The lost relationship may be special in its own right and the resultant grief for that fractured bond, or the grieving can be more complex, associated with other historical or interrelated losses. We may not be good at recognising this, unless we have experienced loss ourselves.

Grief has been described as a normal process with 4 or 5 identifiable stages with different emotions and behaviour:

1. Numbing/shock: we are all familiar with the denial that follows bad news “No! It’s not true!” or the anger that can follow.
2. Yearning/searching
3. Disorganisation/despair
4. Reorganisation: building one’s life back up
5. Acceptance

(NB: anticipatory grief)

The needs of the bereaved

- For the loss to be acknowledged by self and others
- To be given permission to grieve by self and others
- To be given permission to stop grieving by self and others

Loss through death is inevitable and we all have to face it at some stage; for ourselves, our friends and family. For children, the death of a pet is often the first loss of a living companion and the veterinary profession can help to make this early experience important training for later on.

Learning to deal with loss is an important life skill and our profession can maximise the learning experience.

So when you meet a client, you can have no idea what they have experienced in the past or what they are going through, how they are coping (or not) and how they are feeling, as each client’s perspective is very personal and unique. Please do not make assumptions and it is best to avoid saying “I know how you are feeling”, because you don’t.

“What you see of a client on the outside is often NOT what there is on the inside”.

Practices do need to have a clear, proactive idea of how they handle the bereaved client:

- empathic staff
- good practice training and guidelines
- communication especially through informative handouts
- caring environment

Improving your communication and listening skills will be the most effective bereavement support that you can develop. Empathy (i.e. seeing it “through their eyes”) is needed rather than sympathy. Veterinary staff often doubt how they are handling upset clients, but if you are genuine and show nonjudgemental, open minded acceptance and warmth, clients will know that you are trying to do your best and will appreciate you taking the time to be there for them. If in doubt just listen.

In our work, we see a lot of death and we can become more practical and can appear to be less caring. We must reboot ourselves like a computer between cases and approach every situation with a renewed sensitivity.

A clear practice strategy is important for euthanasia appointments, from the time the client starts thinking about it or when it becomes apparent that euthanasia may be required and for all stages of the process. Pay attention to details and make sure the experience is as caring as possible with no rushing, no insensitive comments and focusing on the owner’s and the animal’s needs.

Provide a (complementary) pre-euthanasia discussion to explore all the “end of life” options clearly and help them decide what they want and to reassure clients that they are making the right decisions. Facilitate the chance to say “goodbye” and the rituals of remembrance and memorialisation.

Information packs with leaflets outlining the options, what to expect and what specific extra bereavement support is available, should be given out and prominently displayed in the waiting area.

Condolence letters, sending a small bunch of flowers and follow up phone calls or emails are all gestures of support which will be hugely appreciated. A quiet room at the clinic provides a place for supportive, confidential conversations.

However: You can only support others if “your own house is in order”.

Look after yourself with regular food, exercise and sleep and good personal boundaries. Having discussions with colleagues and specific training is helpful (as is writing a journal expressing your feelings). When you are vulnerable, let others handle upset clients for a while.

You may feel uncomfortable when you are trying to deal with grieving clients but they will all appreciate your respect, sensitivity and kindness, even if they do not show it.

Case studies:

- Kye/Jam/Mia
- AGM lady: condolence letter

Further reading


Death of an Animal Friend Produced by the Society for Companion Animal Studies (SCAS).

Absent Friend by Laura and Martyn Lee, published by Henston

Coping with Pet Loss By Robin Grey, Sheldon Press

Goodbye, Dear Friend by Virginia Ironside, published by Robao.
In recent years, veterinary nursing has gained status and increased recognition as a profession. It was agreed by VN Council that in order to move the profession towards regulated status, a nonstatutory Register for Veterinary Nurses should be opened. Although the Register was opened in 2007, it was decided that the disciplinary system should not come into force until a later date, giving sufficient time for Registered Veterinary Nurses (RVNs) to get used to the changes. It is now hoped that the disciplinary system should be in place from early in 2011.

The aim of this lecture is to discuss the importance of being part of a regulated profession and the benefits it brings to not only the registered nurse, but also to their employers and their clients. The proposed disciplinary process will be introduced and explained: what will happen if a complaint against an RVN / REVN is received by the RCVS.

Registered nurses can be disciplined for serious professional misconduct but what does this mean? The lecture will highlight some of the professional expectations set out in the RCVS Guide to Professional Conduct for Veterinary Nurses and help to clarify some of the misconceptions nurses may have about Regulation.

Further reading
Since the creation of a syllabus and a certifying examination in the early 2000s, equine nursing has been included in the exemptions to Schedule 3 of the Veterinary Surgeons Act. Initially the qualification could only be achieved by those who had passed the small animal examination first, but now there is only a route for direct entry. The original qualification was a certificate entitling the nurse to be described as an EVN. However, a recent decision by the RCVS has changed this and amalgamated the current syllabus for equine and small animal subjects, so that in future the qualification post nominal will be VN (equine). Until the last 2 years the RCVS has held a list of qualified nurses, but this has now been extended to incorporate a register. Registered nurses may be subject to removal from the register if their professional behaviour is found to be inappropriate. Veterinary nurses are empowered by an exemption from Schedule 3 of the Veterinary Surgeons Act and this Act is currently under review. The RCVS ‘Guide to Professional Conduct’ describes the current legal situation regarding equine nurses. However, it should be noted that acts of Veterinary Surgery which may be delegated to a suitably qualified equine nurse are described in generic terms rather than prescriptively. This presentation will cover the sort of work which qualified nurses carry out in a large equine hospital and hopefully outline the marked benefits of using nurses to their full capability.

References

An introduction to the Allied Professionals

Frances M.D. Henson

Department of Veterinary Medicine, University of Cambridge, Madingley Road, Cambridge CB3 0ES, UK.

In order to maintain the health of horses it is important to have a team of well educated health professionals working together. At the current time there is a large problem with poorly qualified people offering diagnoses and treatments to horses. This is a real welfare issue, but one that attracts no major headlines or shocking pictures to offer the public.

We are fortunate in the UK to have some excellent bodies of allied professionals working in the musculo-skeletal field. These professionals are highly qualified Physiotherapists, Osteopaths and Chiropractors, all of whom have had post graduate training and are members of their own professional body. They work with veterinary surgeons, liaising over treatments and progress. In contrast there are people with no formal qualifications, who are not members of professional bodies, diagnosing and treating horses without even notifying the veterinary surgeon - for example the ubiquitous ‘back man’.

The aim of this session of Congress is to highlight this issue, to give a platform to our allied professional colleagues and to begin educating veterinary surgeons, veterinary nurses and the general public about who should and who should not be treating horses.
Thursday 9th September 2010

11.30–11.50

The use of machines in the treatment of musculoskeletal injuries
Sonya Nightingale
Highworth Physiotherapy Clinic, 13 High Street, Highworth, Swindon SN6 7AG, UK.

Electrotherapy has been widely used within the physiotherapy profession for the best part of 100 years. However, its use and application has changed dramatically over the years. There is now a huge body of evidence to support the use of many modalities and evidence based practice is now the norm. Electrotherapy has always had the power to do much good when used in the correct place at the right time. Equally it can have no effect at all if used inappropriately, or worse can cause irreparable damage.

Some modalities that come under the electrotherapy banner are not strictly electrical, ultrasound being a good example, but will be included here as they are definitely machines!

In its simplest format electrotherapy is used to deliver energy to a system, to create a physiological effect and then, hopefully, a therapeutic effect. The clinicians decision is, therefore, which machine used at what dose and for how long, will produce the best physiological and therefore therapeutic effect. Understanding and studying the research evidence will guide and inform these decisions.

The following are the most commonly used machines and are, therefore, the ones mentioned here:

- **Therapeutic ultrasound operates at frequencies between 1 and 3 MHz being most effective on dense collagen based tissues and therefore with injuries over 10 days old. It has a maximum working depth of about 10 cm depending on frequency used.**
- **Shock Wave is simply a very powerful form of ultrasound but rarely used by physiotherapists.**
- **Laser is a monochromatic and coherent light source with a spectrum of use between 600 and 1000 nm. It is most rarely used by physiotherapists.**
- **Pulsed Shortwave uses a frequency of 27.12 MHz** but the output is pulsed to vary the energy emitted. It is most effective working depth of around 15 mm.

Further reading


www.electrotherapy.org - is the best and most comprehensive resource available!


NOTES
Osteopathy, as it is known today, has been around for well over a 100 years. However, few people properly understand what it is, and, more importantly, what it can be used to treat. This paper is concerned with the role osteopathy can play in treating musculoskeletal injuries in the equine patient.

First of all a definition of osteopathy is needed. Osteopathy looks at the dynamic biomechanics of the patient. Most importantly it is used to assess any differential muscle tone, resulting in an altered state of resting tension and therefore the resting position of the various joints of the body. For this state to be present there will also be a neuromuscular aspect maintaining the pattern.

As a form of manually applied medicine, osteopathy is concerned with changing the resting tension of muscles throughout the body, so that ultimately all aspects of the structure are able to function properly, with symmetry and a normal range of movement. Much of what the osteopath does is to affect change to the output of the sympathetic nervous system (SNS) (Stone 1999). Please note that at no point will there be any mention of osteopaths putting things back in place. This is a paper concerned with the realities of applying osteopathy to the equine model by statutory regulated professionals.

Within hours of a musculoskeletal injury there is an activation of the pain gate mechanism. This is where the normal afferent nerve pathway is altered within the spinal cord, resulting in a sustained change in the resting tension of the muscles supplied by the efferent part of the same nerve. It is this pain gate that the osteopath attempts to close (Colles and Pusey 2003).

The way that osteopaths do this varies, partly depending on the type and longevity of an injury. For subacute, minor problems, articulatory sometimes high velocity low amplitude thrusts may be employed, along with more subtle techniques aimed at altering tension through the golgi tendon apparatus.

If a problem is of a long standing, chronic nature it has been found that the use of an intravenous sedative combination prior to actual treatment assists the osteopath to access the central nervous system to the extent required to unravel the complexities of long term changes in conformation and locomotor function. This invariably requires several sessions to achieve and in many cases may require one treatment under general anaesthesia if the problem is particularly well established.

The use of both sedation and general anaesthetic are employed as a way of getting into the central nervous system, or horse’s software, rather than as a way of putting extra force through the musculoskeletal system, or horse’s hardware.

The way osteopaths assess an equine patient should be as follows:
1) Veterinary surgeon diagnoses a musculoskeletal problem and refers to the osteopath.
2) Osteopath (and hopefully with the vet) visually observe the horse standing, in walk, in trot, turning short left and right, reining back.
3) Palpation (if chronic case then after sedation).
4) Osteopathic treatment applied.

One of the traditional ways of assessing the progress of any osteopathic treatment has been to observe the horse move, as well as noting any changes in conformation. This can be rather subjective. At one veterinary practice infrared thermal imaging is used under strict control conditions, to assess changes affecting the SNS. More recently there have been some research theses at Masters level measuring changes in locomotor function (Tyler 2007).

Today osteopaths form a growing section of the professions allied to veterinary medicine. They are keen to integrate and form part of the support available to maintain the health and well being of the equine patient.

Through the help of the General Osteopathic Council (GOsc) the Society of Osteopaths in Animal Practice (SOAP) was set up to help promote the training and sharing of knowledge between graduate osteopaths. SOAP runs several CPD events, as well as a 2 year, part time MSc course. By the end of 2010 it should also have a 1 year university validated post graduate certificate course up and running. It is the intention to expand this to become a modular MSc that can combine animal and human aspects, or be purely animal based.

As of this year SOAP have become the chosen organisation for BEVA members to liaise with the osteopathic profession and as a direct consequence of this SOAP have provided a list of members who treat horses, and comply with all of the legal and professional requirements of both professions (Henson and Nevin 2009).

References
Henson, F. and Nevin, A.R. (2009) Extracts from the minutes of a special meeting between officers representing BEVA, and SOAP. Available from http://www.uksoap.org.uk

NOTES

Osteopathy - its use in musculoskeletal injuries
Tony Nevin
29 Alstone Croft, Cheltenham, Gloucestershire GL51 8HB, UK.

Acupuncture is increasingly recognised as an effective treatment for chronic pain and recent advances in the neurosciences have improved our understanding of acupuncture effects. The historical use of acupuncture in the horse (and animals generally) is debatable due to the lack of satisfactory preservation and interpretation of ancient Chinese texts, but it is clear that the practice in the West today has developed from Western veterinarians adapting Traditional Chinese Medicine for humans along with recent research based acupuncture. Western vets found the human system of acupoints locations and use more accessible - by virtue of the established human acupuncture schools already established in the West and the fact that human acupoints are assigned to a channels (meridian) system while the Chinese animal points were not.

Scientific research has established some of the effects of acupuncture including the up-regulation of the endorphinergic system, normalisation of autonomic nerve functions and a reduction of anxiety and fear related suffering. Acupuncture excites receptors or nerve fibres in the stimulated tissue and cause the release of endogenous opioids and other neuro-transmitters as well as hormones essential to the induction of functional changes in different organ systems.

Acupuncture is mainly used to treat chronic pain, but it can be used more widely in musculoskeletal and neuromuscular disorders, poor performance, training resistances, eye problems, skin disease, endocrine (hormonal) disorders, circulatory and lymphatic faults, respiratory (e.g. COPD or heaves), digestive and reproductive disorders. Reduction of NSAIDs and steroids use is an important consideration for acupuncture use, especially in the area of care for geriatrics with medication side effects issues; and for the sport horse in competition under rules.

Horses generally tolerate acupuncture very well and this presentation will give some of the practical aspects of the treatments including safety, skills and time requirements, case examples, and outcomes.

Further reading
Rehabilitation following injury or surgery is an integral part of human medicine and is carried out by physiotherapists using techniques based on clinical research. In the equine field, rehabilitation techniques are largely extrapolated from human medicine. Mottram and Comerford (2008) state that the biggest predictor of future injury is a previous history of injury. This highlights the need for an effective rehabilitation programme supporting return to work.

The aim of rehabilitation is to restore normal motor control and movement patterns, coordination and proprioception, so facilitating return to function. Specific rehabilitation programmes are dependent upon the type of injury or surgery that has been carried out and also upon the type and level of work the horse will be expected to return to. Thorough assessment and evaluation of clinical signs is essential and a rehabilitation programme should be implemented around specific goals. Effective communication with the referring veterinary surgeon throughout the rehabilitation phase should always be maintained.

An understanding of biomechanics and normal movement is necessary to effectively influence the horse’s return to full function. Assessment of both active and passive range of motion, gait analysis and palpation of soft tissue structures will highlight areas of deficit. Specific physiotherapy interventions such as joint and soft tissue mobilisations or electrotherapy may be applied alongside a programme of therapeutic exercise and are selected as a result of clinical reasoning and constant re-evaluation throughout a treatment programme.

An integral part of rehabilitation is the concept of core training or core stability, which is commonly used in human physiotherapy. To improve core stability we aim to develop strength, function and coordination of the epaxial, abdominal, sub lumbar and pelvic stabiliser muscles. The abdominal muscles along with the sub lumbar muscles (iliopsoas and psoas minor) are recruited to flex and rotate the intervertebral joints. The epaxial muscles (multifidus, sacrocaudalis, longissimus and illocostalis) act to stabilise the spine and control the amount of flexion produced by the abdominal muscles. The deep epaxial muscle multifidus has been found to have a key function in spinal stabilisation and also in proprioception (Stubbs et al. 2006) and therefore has an important role to play in rehabilitation.

Core stability exercises may be initiated whilst the horse is restricted to box rest. Simple weight transfer exercises and bailed stretches activate and strengthen the abdominal and multifidus muscles. Active abdominal contraction can be facilitated by using rounding reflexes effecting an abdominal lift and pelvic tilt. Neuromuscular electrical stimulation (NMES) can be used during this phase to aid in maintenance of hindlimb stabiliser musculature, such as biceps femoris.

Active rehabilitation exercises are carried out initially in hand and then ridden. During in hand work the horse should not use the handler to balance through the lead or lunge rein. Normal movement patterns are encouraged with the use of controlled exercises which can be influenced by rehabilitation tools. Training aids such as the pessoa or theraband body wrap utilise the body’s sensory feedback mechanism, facilitated by the rich supply of sensory nerves in the horse’s skin. These aids are used to encourage pelvic limb protraction and abdominal activation. Taping techniques provide a proprioceptive stimulus which can either facilitate or inhibit muscle activity. Placing the tape parallel to muscle fibres facilitates muscle contraction whilst placing the tape perpendicular to muscle fibres can inhibit muscle contraction (Paulekas and Haussler 2009). This concept may be used to facilitate abdominal activity.

The use of a tactile stimulus to the pastern has been shown to increase the flight arc of the hoof (Clayton et al. 2010). A strap with 6 or 7 short chains is attached around the pastern or above the hock. This technique can be used when working in hand, over poles and during ridden exercise.

Pole work can be used to facilitate coordination, stride length and joint range of movement. Initially, a small number of poles are placed in a straight line on the ground and gradually more complex patterns are introduced, incorporating transitions over poles, raised poles, turns and circles, up and down hills. The effect of different surfaces can be used to re-educate balance and proprioception. Introducing an uphill or downhill gradient during both static and dynamic exercise increases muscular effort and postural control.

As the horse progresses through a graduated ridden exercise programme it is essential to note the importance of the rider as a rehabilitation tool through their ability to influence movement in both a positive and negative manner.

An effective rehabilitation programme should utilise specific veterinary and physiotherapy interventions to ensure pain free range of movement is achievable, alongside strength, balance and proprioception training using clinically reasoned treatment protocols based upon evidence based practice and a thorough knowledge of equine functional anatomy and biomechanics.

### References and further reading


Proceedings of the
49th British Equine Veterinary Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

BEVA Congress
British Equine Veterinary Association
7-10th September 2011 • Liverpool, UK

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Introduction and theory
An electrocardiogram is a recording of the changes in the electrical potential difference of the heart plotted against time. These changes occur during depolarisation and repolarisation of the myocardium and, as the body is a conducting system, this electrical activity can be recorded on the body surface. In horses, the base-apex lead, or modifications of it, is most commonly used to record the electrocardiogram. This lead system produces large complexes, which are easy to identify and is less affected by movement artefacts than the limb leads.

Control of heart rate and rhythm
The heart is instructed to beat by an electrical impulse that originates from a group of specialised cells, the sinus node, situated high in the wall of the right atrium. This pulse of electricity travels quickly through the walls of both collecting chambers and causes them to contract, pushing any remaining blood into the ventricles. For maximum efficiency, it makes sense for the ventricles to delay their contraction until the collecting chambers have completely emptied and that is exactly what happens. Instead of travelling directly into the ventricles the electrical impulse reaches a special area in the muscle between the left and right sides of the heart, the atrioventricular node. Here, the signal is delayed for almost half a second before it continues its journey into the pumping chambers. It is this electrical activity that is recorded at the body surface as an electrocardiogram, or ECG. The ECG is a summated map of the journey of the electrical impulse through the heart (Fig 1).

The first small upward ‘P’ wave comes from the 2 collecting chambers and often as in this example it is m-shaped reflecting the journey through, first the right atrium, then the left. Then the line goes flat, as the impulse is held up at the atrioventricular node allowing the atria to empty. The large downward pointing signal, ‘QRS’ wave, is the rapid journey of the impulse around the muscle of the ventricles. As the impulse passes through each muscle cell, their electrical charge is reversed and the final ‘T’ wave represents the ventricular myocardium returning itself back to normal in readiness for the next heart cycle. Notice that the line should be flat between heart beats (Fig 2).

ECGs in horses are normally recorded using a simple base-apex lead configuration at a paper speed of 25 mm/s and 1 cm/mV. At this speed and sensitivity each small vertical box represents 0.1 millivolt, each small horizontal box represents 0.04 s (40 ms). Unlike in small animal patients, because of the special pattern of depolarisation of the horse’s heart, no useful information can be obtained about chamber enlargement using measurements of intervals or complex heights, so analysis is restricted only to rhythm, making interpretation of equine ECGs really easy in comparison.

General rules in interpreting ECGs
1) Assess the quality of the trace
If the quality is poor, reposition your electrodes, or improve their contact. A bad ECG is worse than no ECG!

2) Calculate heart rate
This can be obtained by counting the number of complexes in a 6 second strip and multiplying this by 10. However, just as it is
unreliable to determine the pulse rate from a 6 s examination, calculation of the heart rate from a longer time strip would be more representative. This is especially true when the heart rate is low. Alternatively heart rate can be calculated by dividing 60 by the R-R interval in seconds.

Base-Apex traces in horses are normally recorded at a paper speed of 25 mm/s. At this speed each small vertical box represents 0.1 millivolt, each small horizontal box represents 0.04 s (40 ms).

It is really important to know whether the heart rate is unusually fast or too slow

3) Is there a P:QRS ratio of 1?
Is there a P wave for every QRS complex and a QRS complex for every P wave?

4) What is the predominant rhythm?
Inspection of the regularity of the QRS complexes will indicate if there is a dysrhythmia present. Inspect the regularity and configuration of the P and QRS complexes. What is their relationship?

Equine rhythms

Normal sinus rhythm, sinus and 2nd degree atrioventricular block
The electrical impulses fire off repeatedly from the right atrium providing a regular rhythm. As a horse becomes fitter the rate of firing is damped down because the larger more muscular heart needs not beat so frequently. In human athletes this damping occurs at the source of the impulse in the right atrium, so overall pulse rate slows down. In horses this damping is most likely to occur further down the impulse’s journey, where it is delayed between the chambers at the atrioventricular node. This is why a normal horse will regularly miss beats at rest. In fact the collecting chambers do contract but the electrical signal is blocked before the pumps can be activated. This is called 2nd degree atrioventricular block, so called because the impulse stops between the atria and ventricles at the atrioventricular node. An example of this can be seen below, when every third ‘P’ wave is not accompanied by an ‘QRS’ or ‘T’ wave (Fig 3).

Occasionally the impulse is blocked before it leaves the sinus node, the effect is the same, but this time ‘P’ waves are also absent (Fig 4).
Both these rhythms are a normal way for a resting horse to control its blood pressure. Only when they fail to be abolished by exercise or excitement is there any cause for concern.

Occasionally the heart rhythm can go wrong and the most common example occurs in the condition called atrial fibrillation.

What happens in atrial fibrillation
In atrial fibrillation the electrical activity of the collecting chambers is completely deranged. As a result, instead of beating regularly in a coordinated pumping motion, the atria beat completely out of sync. In fact to the naked eye a fibrillating atrium looks just like a ‘bag of worms’. The uncontrolled chaotic electrical activity of the atria is visible on an ECG as a constant irregular wavy baseline, instead of regular neat little ‘P’ waves. Meanwhile the ventricles are being bombarded by electrical nonsense from their control centres. They do their best, but there is no longer a regular heart rhythm with the odd missed beat, instead there is a chaotic irregular rhythm (Fig 5).

Premature beats and other irregular rhythms
They can originate from the atria, the atrioventricular junction, or the ventricle and their origin determines their shape.

Premature atrial systoles
In horses with premature atrial systoles, ‘P’ waves occur which are earlier than expected from the dominant underlying ‘P-P’ interval. If the ‘P’ wave occurs after the refractory period of the ventricles, it is conducted and a normally configured ‘QRS’ complex follows earlier than expected from the underlying ‘R-R’ rhythm. The ‘P’ wave of the premature complex may have a different configuration to the normal ‘P’ waves. Premature ‘P’ waves are sometimes buried in the previous ‘T’ wave causing it to have an altered shape (Fig 6).

Fig 3.

Fig 4.
Premature ventricular systoles
On ECG examination the premature ‘QRS’ complexes have a wide bizarre configuration, as ventricular depolarisation does not follow the normal pathways (Fig 7).

Ventricular fibrillation
A fatal dysrhythmia where there are no organised ventricular depolarisations. The ECG shows an undulating baseline with no ‘P’, ‘QRS’ or ‘T’ waves (Fig 8).

NOTES
Physical examination:

3. Gastrointestinal (GI) or ‘visceral’ pain due to distension of the part of the gastrointestinal tract, spasm/hypermotility of the intestine, tension on the intestinal mesentery or ischaemia of a portion of the gut.

Nongastrointestinal or ‘parietal’ pain e.g. due to a primary septic peritonitis or peritonitis secondary to gastrointestinal rupture.

In addition, there are a number of other conditions that can manifest with clinical signs that can look like colic but are due to body systems other than the gastrointestinal tract e.g. urogenital (e.g. uroliths), musculoskeletal (e.g. exertional rhabdomyolysis/tying-up) or hepatic (e.g. cholelithiasis).

Colic examination

There are several stages to the assessment of any colic patient. Whilst not all stages are completed in every case e.g. a violently painful horse with suspected large colon volvulus may be a poor candidate for abdominocentesis, each can provide valuable information in the overall assessment of the horse.

1. Signalment: age, breed and gender of the horse
   i. Can provide valuable insight into the potential disease process as certain types of colic are more common in certain age groups e.g. intussusceptions in young horses <2 years old or strangulating lipomas in older horses e.g. >15 years old

2. History: of current colic episode and patient’s prior medical and management history
   i. Colic: how long, how painful, medications received
   ii. Previous history of colic
   iii. Worming history
   iv. Changes in management, feeding, plane of exercise and bedding

3. Physical examination: complete physical examination including:
   i. Attitude: alert, depressed, anxious
   ii. Initial degree of pain:
      a. Mild: occasionally paws, looks at abdomen
      b. Moderate: frequently paws, looks at abdomen, lies down and rolls
      c. Severe: Continuous attempts to lie down and roll
   iii. Abdominal distension: none/ slight/moderate/severe
   iv. Evidence of previous pain level e.g. dried sweat on coat, abrasions and hair loss (e.g. around eyes, neck, hip)
   v. Physical examination: complete evaluation of each body system with particular reference to:
      a. Temperature, Pulse and Respiration (TPR)
      b. Mucous membranes inc. colour and capillary refill time
      c. Peripheral pulses
      d. Borborygmi - present, increased or decreased

4. Blood work: may be basic or more in depth depending on the results of the clinical examination
   i. PCV and total protein - basic evaluation of hydration
   ii. Haematology (in EDTA; purple/lilac tube) - white blood cell count, differential count
   iii. Fibrinogen and serum amyloid A: markers of inflammation
   iv. Biochemistry (in heparin/green top tube or serum/red top tube) - creatinine/urea: renal function; muscle enzymes; liver enzymes; bile acids; bilirubin
   v. Venous blood gas (heparinised syringe) for assessment of acid-base balance and electrolytes
   vi. Serum lactate: useful in evaluating perfusion and as an early indicator of strangulating obstructions

5. Rectal examination: NB adequate restraint is vital for the safety of the horse and the vet!
   i. Evaluate for ‘normal anatomy’
   ii. Abnormal gas, feed or fluid distension of any viscous

6. Nasogastric intubation
   i. >1 l net reflux is abnormal
   ii. Note character of fluid and gas relieved
   iii. Monitor patient’s response to decompression of the stomach

7. Abdominocentesis
   i. SITE: most dependant part of the abdomen, caudal to the xiphoid on midline or to right of midline (to avoid spleen) or under ultrasound guidance
   ii. Aseptic preparation including clipping hair if necessary

8. Ultrasonography
   i. Transrectal or transabdominal
   ii. Invaluable if patient is too small for rectal examination e.g. foal or if rectal inconclusive
   iii. Evaluate wall thickness of intestine, presence and character of abdominal fluid, gastrointestinal distension, liver/kidney anatomy

9. Other diagnostic procedures: Endoscopy, Radiography, Laparoscopy
   i. Endoscopy: for diagnosis of gastric ulceration
   ii. Radiography: for foals; penetration poor in adults but can still help in diagnosis of sand impactions and enteroliths
   iii. Laparoscopy: minimally invasive further diagnostic in cases of recurrent low-grade colic

Intravenous fluid therapy

Part of the initial colic examination includes evaluation of the degree of dehydration the horse is suffering from and what signs it has of circulatory compromise e.g. poor peripheral pulses, prolonged CRT and poor mucous membrane colour and elevated lactate level. As a broad guideline:

<table>
<thead>
<tr>
<th>Severity of dehydration</th>
<th>PCV (%)</th>
<th>TP (g/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (6%)</td>
<td>43–50</td>
<td>70–82</td>
</tr>
<tr>
<td>Moderate (8%)</td>
<td>50–55</td>
<td>83–90</td>
</tr>
<tr>
<td>Severe (10%)</td>
<td>&gt;55</td>
<td>&gt;90</td>
</tr>
</tbody>
</table>

Initial fluid resuscitation is necessary to correct hypovolaemia and support circulating blood volume/perfusion. Fluid therapy should then be targeted at reversing dehydration, matching...
ongoing losses e.g. reflux or diarrhoea and providing maintenance
requirements.

Response to fluid therapy and other indicators of dehydration
e.g. urine specific gravity, creatinine and lactate concentrations,
and PCV and total solids is important in evaluating the success
of initial fluid therapy and gauging what alterations need to be
made to this treatment to meet the patient’s ongoing needs.

**Intravenous catheter placement**

**Short stay catheter:** large bore, over the needle, often stiff
material e.g. polyethylene. Easy/rapid to place but increased risk
of thrombophlebitis.

**Long stay catheters:** 14 or 16 gauge; over-the-wire placement;
usually softer, more flexible material e.g. polyurethane, more
difficult/time consuming to insert.

**Types of fluids:**

**Crystalloids**

- Balanced electrolyte fluids e.g. lactated Ringer’s solution are
  the most common fluid type for rehydration in horses.
- Hypertonic saline (7.2%): for rapid re-expansion of the
circulating blood volume; dose = 2–4 ml/kg bwt, i.e. 1–2 l for
500 kg Thoroughbred. Draws fluid from the intracellular fluid
into the extracellular fluid/blood stream to temporarily restore
circulation but this deficit must be replaced with balanced
electrolytes within 2.5 h (need approx 5 x volume of
hypertonic administered) to replace this deficit.

**Colloids**

- These are solutions containing large sugar or protein
  molecules in addition to water and electrolytes. This remains
  in the circulation for longer than crystalloids and exert greater
colloid oncotic pressure (draws more fluid into the circulation
to increase circulating blood volume).
- Pentastarch (UK) and hetastarch (USA) (hydroxyethyl starches)
  - administered at 10–15 ml/kg bwt for pentastarch for ‘shock’
treatment of hypovolaemia; changes in coagulation (reduced
  thrombin time) have been noted after administration to
  healthy horses but the maximum daily dose to avoid
  coagulation problems has not been documented. Caution
  should be exercised in using it in horses with active
  haemorrhage, suspected coagulopathies or other bleeding
  problems.

**Plasma, blood and blood components**

- **Whole blood:** should be considered if PCV <18%
  (haemoglobin <6 g/dl) and imperative if PCV <12%;
  \[
  \text{amount of blood (ml)} = \text{bodyweight (kg)} \times (\text{desired PCV} - \text{current PCV}) \times Z
  \]
  \[
  \text{Donor PCV}
  \]
  \[
  Z = \text{blood volume of recipient per kg bwt (80 ml/kg bwt}
  \]
  \[
  \text{adults; 150 ml/kg bwt for 2-day-old foal)}
  \]
- **Plasma:** for treatment of failure of passive transfer of
  immunity in foals and colitis; need large volumes of plasma
to treat clinically significant hypoproteinaemia in adult horses
(6–8 l necessary to increase plasma total protein by 5–10 g/l
(and therefore becomes expensive at about £100/litre))
  o Also useful for replacing antithrombin III, protein C and
  other cofactors that become depleted in systemic
  inflammatory response syndrome (SIRS; e.g.
  endotoxaemia, sepsis, trauma and ischaemia). Fresh
  frozen plasma (stored less than 1 year) preferable as these
  important proteins decline in concentration over storage
time.

**Criteria for surgical intervention**

1. Severe and unrelenting pain
2. Abnormal rectal findings
3. Serosanguinous peritoneal fluid sample

Other factors that in combination may influence the decision for
surgery:

- High heart rate (>60 beats/min)
- Congested/injected/cyanotic mucous membranes
- Absence of gastrointestinal sounds or progressive reduction
  in motility
- Progressive abdominal distension
- Large volumes of NG reflux with persistent pain
- Abnormal peritoneal fluid (>25 g/l total protein; >10,000
cells/µl)
- Evidence of physiological deterioration (increasing heart rate,
  increasing serum lactate, cold extremities).
Haematology
White cells: the 2 predominant white cells are neutrophils and lymphocytes

**Neutrophils:**
- Phagocytose (engulf and destroy) foreign material, especially bacteria.
- Increase:
  - bacterial infections especially chronic bacterial infections, such as strangles
  - 'Stress' neutrophilia if it is accompanied by a lymphopenia
- Decrease:
  - Acute severe infection or inflammation, especially involving the GIT
  - A 'left shift' (increased concentration of immature or band neutrophils) may also be seen

**Lymphocytes:**
- Two main types: B and T
- B cells (plasma cells) produce antibodies
- T cell involved in immune response
- Increased lymphocyte count rare:
  - Chronic infections
  - Leukaemia
- Low lymphocyte count: acute infection or stress

**Other markers of inflammation or infection**

**Fibrinogen and serum amyloid A (SAA)**
- Produced by the liver
- Fibrinogen increases more slowly (over several days) and decreases more slowly than SAA
- Useful to monitor response to treatment

**Globulins**
- Increase:
  - Chronic infection
  - Dehydration will cause a relative increase (albumin will also be high)

**Iron**
- Low iron levels associated with bacterial infection (rarely used)

**PCV/HCT**
- Measure of red blood cells
- Increased PCV
  - Dehydration
  - Stress (spleen contracts and releases stored red cells into circulation)
- Decreased PCV (anaemia)
  - Blood loss
- Can be internal or external
- PCV will take at least 12 h to go down with acute blood loss
  - Haemolysis
  - Destruction of red cells e.g. immune mediated
  - Decreased production by bone marrow
  - Most commonly associated with chronic disease (PCV usually 25–30%)
  - Bone marrow disease rare

**Total protein**
- Made up (primarily) of albumin and globulin
- Increase:
  - Dehydration (both will increase)
  - Chronic infections (globulins increase)
  - False increase: if measure total solids on refractometer, will have high reading if eg hyperlipaemia as measure fats as 'solids'
- Decrease:
  - Globulin decrease rare
  - Albumin decrease: usually due to loss into GIT e.g. diarrhoea. Can also be lost via kidneys or into pleural/peritoneal space if disease in these cavities

**Biochemistry**

**Sodium and chloride**
- Electrolytes: mainly in extra-cellular fluid
- Low Na/Cl: GI disease, renal disease, excessive sweating (electrolytes are lost in diarrhoea, reflux, etc.)

**Potassium**
- Main electrolyte in cells
- Low levels often seen in horses off feed (feed is major source of potassium)
- High potassium: ruptured bladder (foals); renal failure

**Calcium**
- Low Ca often seen with GI disease
- Two forms: total and ionised. The active form is ionised (most chemistry analysers will only measure total calcium, which can be low if total protein is low)

**AST**
- Enzyme found in liver and muscle cells
- Elevated levels reflect muscle or liver damage therefore need to interpret alongside other muscle (CK) and liver enzymes (SDH or GLDH)

**CK**
- Enzyme found mainly in skeletal muscle
- Increased concentrations reflect muscle damage which may be primary e.g. rhabdomyolysis or secondary e.g. prolonged recumbency

**SDH**
- Enzyme found in liver cells
- Specific for hepatocellular damage
GGT
- Enzyme found in the bile ducts of the liver and increases are associated with diseases affecting the biliary tract of the liver
- Considered a sensitive indicator of liver disease

Bilirubin
- Produced in the breakdown of red blood cells in the blood (unconjugated form)
- Unconjugated bilirubin is then removed from the blood by the liver and modified for disposal in bile (conjugated)
- Increased unconjugated bilirubin: increased breakdown of red blood cells (haemolysis), inappetence or liver disease
- Increased conjugated bilirubin: obstruction to the outflow of bile

Bile acids
- Removed from the blood by the liver
- Marker of liver function

Triglycerides
- Reflect mobilisation of fat in the body during prolonged inappetence
- Hyperlipaemia can be a life threatening consequence of diseases resulting in anorexia
- Common in ponies, donkeys, pregnant and lactating mares

When to suspect:

Dehydration
1. Increased PCV/Hct
2. Increased TP/TS
3. Increased lactate
4. Increased creatinine/BUN

Infection
1. Increased/decreased white cell count
   a. +/- ‘left shift’ (increased concentration of immature or ‘band’ neutrophils)
2. Increased acute phase proteins
   a. Fibrinogen
   b. Serum amyloid A
3. Increased globulin concentration
4. Decreased Iron concentration

Anaemia
1. Decreased PCV/HCT

Liver disease
1. Increased liver enzymes
   a. AST, SDH
   b. GGT, ALP
2. Increased bile acids
3. Increased bilirubin
4. Increased ammonia
5. Increased globulins
6. Abnormal clotting times

Renal disease
1. Increased creatinine and BUN
2. Anaemia
3. Decreased albumin
4. Electrolyte abnormalities
5. Urinalysis

GIT disease
1. Low white cell count
   a. Neutropaenia
   b. Left shift
   c. Toxic changes
2. Increased globulins
3. Decreased albumin
4. Electrolyte abnormalities

Muscle disease
1. Increased CK
2. Increased AST

NOTES
Interpretation of blood gas analysis should be performed in a logical, consistent fashion. Blood gas analysis provides information regarding oxygenation, ventilation, and acid/base status. Six steps can be used to interpret blood gases:

1. Step 1: Determine whether the blood samples are arterial or venous.
   a. If $\text{SO}_2 > 88\%$, the sample is almost certainly arterial.
   b. If $\text{SO}_2 < 88\%$, the sample could be venous, mixed, or could be an arterial sample from a patient with disease.

2. Step 2: Determine the acid/base status.
   a. Determine whether the patient is acidic (pH below reference range), alkalemic (pH above reference range), or normal pH.
   b. Determine whether pCO$_2$ is normal or abnormal.
   c. Determine whether HCO$_3$ is normal or abnormal.
   d. Using the information from 2a–2c, determine whether the primary problem is respiratory in origin or metabolic in origin.
   e. Determine whether compensation is occurring.

3. Step 3: Assess the ventilatory status.
   a. If PaCO$_2$ is decreased, the patient is hyperventilating.
   b. If PaCO$_2$ is increased, the patient is hypoventilating.

   a. Calculate the A-a gradient (normal A-a gradients change depending on whether the patient is inspiring room air or inspiring supplemental oxygen).
   b. Determine the anion gap if electrolytes are available.
      a. Anion gap = ($\text{Na}^+$ + $\text{K}^+$) - ($\text{HCO}_3^-$ + $\text{Cl}^-$)

Interpretation of blood gas analysis will be reviewed using case examples.

**Acid/base status (Fig 1)**
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Next Congress:

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Nutrition: from racehorse to ancient Shetland

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The impact of diet upon physiological systems such as the digestive tract, respiratory system and skeletal system has commonality between breeds as diverse as Thoroughbreds and Shetland ponies and also has no ageist barriers. Whilst there may be some differences in the subtle functioning of the gastrointestinal tract between ponies and Thoroughbreds, for example in terms of voluntary dry matter intake and diet digestibility (Cuddeford et al. 1995), the nutritional pitfalls remain remarkably similar.

One of the greatest limitations of the equine digestive system is the seeming ease with which the hindgut ecosystem can become disrupted by an increased influx of rapidly fermentable carbohydrate, either in the form of undigested starch (Medina et al. 2002) or grass fructan (Milinovich et al. 2008), with often severe health consequences in the form of colic, colitis or laminitis. Despite the evidence that large high starch meals, uncooked cereals and inadequate levels of forage can significantly contribute to hindgut acidosis (Medina et al. 2002; Julliand et al. 2006) tradition amongst the racing and performance horse communities remains firm, adding to a heightened risk of digestive disorders. Equally, many pony owners battle against a pony’s ingrained over consumption of grass and recent evidence suggests that this ‘will to feed’ is high in these animals which can consume up to 40% of their daily dry matter intake in 4 h or less (Harris and Geor 2007). Whilst adjustments in feeding management are to be applauded in both these scenarios, other additions to the diet such as live yeast probiotics and hindgut buffers may offer some benefit. Live yeast probiotics (Saccharomyces cerevisiae), which should be distinguished from bacterial probiotics for which in contrast there is little supporting evidence, have been shown consistently to ameliorate the impact of a high starch diet on the hindgut environment and ecosystem (Julliand and Zehner 2008). Equally, preliminary data on encapsulated bicarbonate is interesting regarding its potential in buffering hindgut acidity (Pagan et al. 2007).

Airway inflammation and associated secondary infection is a cause for concern amongst racing veterinarians. However, equally, recurrent airway obstruction (RAO, heaves) is a significant issue for many ponies particularly as they age. Forage quality is central to respiratory health irrespective of the breed, age or activity of the individual. The climate in the UK necessitates an awareness of the potential for mould and associated mycotoxin contamination of hay. The use of preserved hay in the form of haylage can offer an advantage due to the inhibition of mould growth by the acidic products of fermentation. Likewise soaking of hay and the relatively new introduction of hay steams into performance and racing yards may significantly reduce mould burden. However, mycotoxins, which are chemical metabolites produced by moulds are inherently difficult to remove or destroy, being largely unaffected by heat and other sterilisation procedures. Whilst there is no doubt that mycotoxins are ubiquitous within the environment (Reddy et al. 2010), research pertaining to the significance of their levels and relative impact on equine health is in its infancy and the value of feed ingredients that function as mycotoxin binders, remain to be fully evaluated. The impact of antioxidants such as vitamin E and vitamin C is significant with regards to horses having airway inflammation or RAO (Kirschvink et al. 2002). Hyper-supplementation with these vitamins does not appear to offer a clearly definable beneficial effect on respiratory function in normal horses, although a genuine benefit may exist but be obscured by differences in the relative availability of ingredients such as synthetic vs. natural vitamin E (Pagan et al. 2005) and ascorbic acid vs. ascorbyl palmitate (Deaton et al. 2003).

Maintaining joint health is a major concern across a wide spectrum of horses from Thoroughbreds in race training to aged ponies and the use of ‘chondroprotective’ supplements continues to be popular with consumers. Ingredients such as glucosamine, chondroitin sulphate and their precursors, MSM, and hyaluronic acid are frequently found in such feed supplements. Their use is common across most equine sporting disciplines, as well as within the leisure horse or pony sector and their popularity persists despite an absence of substantive data relating to bioavailability, mode of action and efficacy for some of the ingredients, as well as concerns regarding the standards of quality control exerted during manufacture (see review) (McIlwraith 2008). Current legislation precludes the use of medicinal claims in relation to the promotion of products of this type, although a semantic tightrope is often walked in an attempt to convey a marketing message. Whilst we should not dismiss such ingredients, much more research is needed to properly evaluate such nutraceuticals.

References
Thursday 9th September 2010


Fluid therapy plays a critical role in the therapy of most seriously sick animals and a supportive role in animals undergoing anaesthesia. An ability to understand some basic principles and apply these can make a major improvement in case management. This starts with addressing the hydration status of the patient which then enables decisions to be made such as the type of fluid to be given, the route of administration and the volume needed. Approximately 60% of an adult horse’s bodyweight is water (80% in foals) and this is divided with approximately two-thirds in the intracellular space (ICF) and one-third in the extracellular space (ECF) (Fig 1). The effective circulating volume is the ECF that is in the vascular space and effectively perfusing tissues. This varies directly with the ECF volume and the total body sodium (the primary solute holding the water in the ECF). Oncotic pressure is also important as plasma proteins, specifically albumin, hold the water within the vasculature.

Water loss can be divided into sensible losses, such as from the urinary and gastrointestinal tract and insensible losses, such as respiration and sweating. Normal ongoing losses for a resting adult horse are 55–65 ml/kg bwt/day, or about 25 l for a 500 kg horse.

Assessment of hydration status

Physical examination will guide fluid therapy. Skin turgor and moistness of mucous membranes provide an indicator of total body water, whilst circulating fluid volume can be estimated from heart rate (HR), capillary refill time (CRT), pulse pressure, jugular filling time and temperature of extremities (Table 1).

Laboratory parameters including packed cell volume (PCV), total protein (TP), urine specific gravity, creatinine/BUN, blood lactate, central venous pressure and arterial blood pressure all provide further useful information. Remember that PCV and TP must always be interpreted together and are most useful when monitored serially.

How much fluid to give?

- Replace deficit
- Replace normal ongoing losses
- Replace continuing abnormal losses

Replacing the deficit in adults can be done over 2 h; in foals the first half should be done in the first 6 h and the rest over the next 12–24 h.

A maintenance rate for adults is 55–65 ml/kg bwt/day, or 1–2 ml/kg bwt/h and for neonates is 80–120 ml/kg bwt/day, or 3–5 ml/kg bwt/h.

Judging abnormal ongoing losses can be hard, but when possible should be taken into account. An adult horse with diarrhoea can lose up to 100 l/day, but remember it will also lose protein.

Types of fluids

- Crystalloids: Balanced electrolyte-containing solutions which increase plasma volume without causing electrolyte disturbances. However, they decrease oncotic pressure (they contain small particles) and can be associated with oedema formation. Examples include Lactated Ringers solution and Hartmann’s solution. 0.9% saline only should be used with caution and only when lab values are available.
- Hypertonic saline (7.2%): restores circulating fluid volume quickly, increasing cardiac output and blood pressure. For emergency management of hypovolaemia give 2–4 ml/kg bwt as fast as possible. Follow with isotonic fluids.
- Colloids: contain large particles which help increase oncotic pressure; only a small volume is required. Examples include whole blood, plasma, pentastarch.

Table 1: Clinical signs to estimate fluid deficit

<table>
<thead>
<tr>
<th>Dehydration</th>
<th>Mucous membranes</th>
<th>CRT (s)</th>
<th>Skin tent (s)</th>
<th>HR (beats/min)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Mild</td>
<td>Normal – mildly tacky</td>
<td>&lt;2 (normal)</td>
<td>1–3</td>
<td>Normal</td>
<td>Mildly depressed</td>
</tr>
<tr>
<td>8–10% Moderate</td>
<td>Tacky</td>
<td>2–3</td>
<td>3–5</td>
<td>&gt;50</td>
<td>Depressed, sunken eyes, weak peripheral pulse</td>
</tr>
<tr>
<td>12% Severe</td>
<td>Dry</td>
<td>&gt;5</td>
<td>&gt;5</td>
<td>&gt;60</td>
<td>Moribund, severely sunken eyes, cold extremities</td>
</tr>
</tbody>
</table>

% dehydration x bodyweight (kg) = fluid deficit (litres)
Routes of administration

- **Oral**: if needs not immediate and dehydration not severe. Useful for mild dehydration if intestinal tract capable of absorbing fluid. Contraindicated if gastric reflux is present - always check first.
- **Intravenous**: should always be used if animal >7% dehydrated, meets immediate needs and allows for precise control of fluid delivery. With a standard i.v. jugular catheter (14 gauge, 5.25") fluids can be administered at 5–7 l/h. If more than this is needed, may need to place more than one catheter, although this makes venous thrombosis more of a potential problem.
  - ‘Adult’ curly drip giving set (e.g. International WIN, Ltd Large Animal IV Sets) gives 10 drops/ml, therefore 3 drops/s gives a fluid delivery rate of 1 l/h.
  - Most ‘paediatric’ or ‘foal’ sets give 60 drops/ml, therefore 4 drops/s gives a fluid delivery rate of 250 ml/h. But, always check the set you are using. It is preferable to use a fluid pump machine to accurately give fluids in neonates who are very susceptible to fluid overload.
  - Oral administration in adults by nasogastric tube: can give up to 8 l every 2–4 h to a 500 kg horse.

Balancing electrolytes

Most hay is rich in potassium (K⁺) and low in sodium (Na⁺), so horses typically consume an excess of K⁺ and a marginal amount of Na⁺ which is reflected in the urine. Urine from normal hydrated horses will contain high concentrations of K⁺ and low concentrations of Na⁺. Most fluids are similar to plasma in that they are high in Na⁺, but low in K⁺. Furthermore, horses which are off feed will continue to lose K⁺ in their urine, despite a lack of intake. It can therefore be important to supplement fluids with potassium, especially in horses which have been inappetant for more than a few days or have been on fluids for more than 48 h. Depletion of K⁺ leads to muscle weakness and can contribute to post operative ileus, for example. Can supplement 15–50 mEq/l KCl i.v. for a 500 kg horse (0.03–0.1 mEq/kg bwt/h), but must never exceed 0.5 mEq/kg bwt/h. Oral supplementation is 10–80 g/day for a 500 kg horse.

Further reading

**Nutritional support for hospitalised cases, incl. TPN**

*Alex McSloy and Imogen Johns*

The Royal Veterinary College, North Mymms, Hertfordshire, UK.

Nutritional support plays an important role in stabilising patients and providing the body with a means of recovery from illness. In certain conditions a negative energy balance can be life threatening.

**Importance of nutritional support**

Many patients will have a decreased voluntary food intake resulting in a negative energy balance. This in turn is associated with fatigue, an excessive loss of lean body mass, immunosuppression, delayed wound healing and mobilisation of fatty acids.

**Patients requiring nutritional support**

All hospitalised animals with a decreased appetite benefit from support, but certain cases in particular will present more of a challenge such as those with dysphagia or difficulty eating from jaw fractures or gullet pouch disease. Patients with gastrointestinal disease will also warrant special attention and can be very difficult to manage. Those predisposed to hyperlipaemia, including ponies, miniature horses, donkeys and pregnant and lactating mares must be closely monitored and treated as necessary. Finally long term residents, such as limb fractures, lose weight gradually and can be hard to track as they are seen every day but often cannot be weighed accurately on scales.

**Monitoring techniques**

It is imperative to know what and how much an individual horse has eaten over any 24 h period; this can be particularly problematic in a hospital setting where the animal may be fed several times a day by multiple personnel and the stable cleared by different people again. To combat this, every hospitalised horse should have a feeding chart kept if possible by the stable door for easy access and it should be impressed upon all staff that this must be kept up to date. This chart should also form part of the animal’s medical record. Feed, both being given and discarded, must be kept up to date. This chart should also form part of the easy access and it should be impressed upon all staff that this has eaten over any 24 h period; this can be particularly problematic in a hospital setting where the animal may be fed several times a day by multiple personnel and the stable cleared by different people again. To combat this, every hospitalised horse should have a feeding chart kept if possible by the stable door for easy access and it should be impressed upon all staff that this must be kept up to date. This chart should also form part of the animal’s medical record. Feed, both being given and discarded, must be kept up to date.

**Methods of nutritional support**

Some basic rules still apply when feeding horses with decreased appetites such as feeding little and often, keeping a regular routine and not making any sudden feed transitions. Forages should still form the majority of the diet and for horses that can be walked out in hand, grazing is a useful appetite stimulant, or grass can be handpicked and offered. During inappetant periods it can be useful to offer horses a ‘Smorgasbord’ of different feeds and adding a little molasses or warm water to release aromas can help.

**Enteral nutrition**

“If the gut works, use it” - many studies have shown that enteral nutrition is more effective than parenteral in supporting organ function and blood flow, patient weight gain and immune function principally due to its effects on the gastrointestinal mucosa. Enteral feeding helps maintain the role of the intestinal epithelium as a principal barrier to pathogenic microorganisms.

Enteral nutrition can encompass everything from normal feedstuffs, to slurry diets made from normal feeds to specially formulated component liquid feeds. Horses with a decreased appetite can be fed initially via a nasogastric tube, although placement of an indwelling oesophagostomy feeding tube may be necessary if prolonged feeding is expected in horses with dysphagia, oral or head and neck trauma, or prolonged anorexia with a functional gastrointestinal tract (GIT). Long term nasogastric intubation requires use of a small bore flexible soft tube which precludes the use of slurry feeds usually due to the small diameter and necessitates the use of equine liquid formulations.

**Parenteral nutrition**

This is required when a lack of gastrointestinal function contraindicates the use of enteral nutrition, such as the presence of gastric reflux. Its aim is to minimise catabolism and malnutrition but it has several disadvantages such as increasing the risk of thrombophlebitis, adding metabolic complications and by definition there is a loss of the positive effects that enteral nutrition has on the GIT leading to decreased motility and function. Patients on parenteral nutrition also require intensive nursing. Components used in parenteral solutions include proteins, lipids, carbohydrates, vitamins, electrolytes, minerals and trace elements.

**Timing of nutritional support**

Certain groups of patients require immediate support such as foals, patients at risk of hyperlipaemia or with increased triglycerides and lactating or pregnant mares. Others should aim to be addressed within 48 h of hospitalisation, these include patients withheld from feed for >24–48 h, maldrenched or inappetant patients and those who have oral/oesophageal disease. Other patients may improve once their level of pain is better controlled and can be watched for a few days to see if this occurs.

**Further reading**


**Thursday 9th September 2010**

### Equine Referral Hospital Feeding Record

<table>
<thead>
<tr>
<th>Case No.:</th>
<th>Box No.:</th>
<th>Clinician:</th>
<th>Referring Veterinary Surgeon:</th>
<th>Admitting Technician:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse:</td>
<td>Sex:</td>
<td>Age:</td>
<td>Presenting Complaint:</td>
<td></td>
</tr>
<tr>
<td>Date of Admission:</td>
<td>Date of Discharge:</td>
<td>Breed:</td>
<td>Weight on Admission:</td>
<td>Weight on Discharge:</td>
</tr>
</tbody>
</table>

#### Special Considerations:

**DAY & DATE:**
- Body Weight - kg
- Technician Initials:

**Time of Day:**
- AM | PM | AM | PM | AM | PM | AM | PM | AM | PM

**HARD FEED:**
- AM
- PM

**WEIGHT (KG):**
- AM
- PM

**SPECIAL FEEDS, SPECIFY QUANTITIES:**

**Drug:**
- (ORAL DRUGS ONLY)
- Dose, Route, Frequency:
- Batch No.:
- Signature:

**Drug:**
- (ORAL DRUGS ONLY)
- Dose, Route, Frequency:
- Batch No.:
- Signature:

**ROUGHAGE (Circle):**
- DRY HAY
- WET HAY
- HORSEHAGE

**Weight of roughage – kg:**

**STABLE CHECK**
- Water Intake
- Hard Feed Eaten
- Appetite for roughage:
- FARCIES
- URINE

**General Demenour & Comments:**

**KEY:**
- N = Normal
- E = Excessive
- R = Radicoid
- A = All
- D = Diarrhoea
- P = Port
- G = None
- L = Lique
- H = Hard
- S = Starve

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*Fig 1: An example of a feeding chart used in a hospitalised setting.*
Proceedings of the
49th British Equine Veterinary Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

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Use of direct and indirect ophthalmoscope and slit lamp

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Introduction

Although the direct ophthalmoscope is the main item of equipment used to evaluate the eye in equine practice, both the indirect ophthalmoscope and slit lamp are extremely useful and ought to be used more widely. The indirect ophthalmoscope allows visualisation of a much greater area of the fundus than the direct ophthalmoscope and the slit lamp allows precision evaluation of the anterior structures of the eye, especially the cornea. In all cases, a dark room is essential and it is difficult to carry out an adequate ocular examination in day light no matter what equipment is used.

Direct ophthalmoscopy

The direct ophthalmoscope is a very versatile instrument and for many practitioners is the mainstay of ocular examination. The instrument is inexpensive, simple and intuitive to use and robust. It can be used to evaluate all regions of the eye, although is most suited to assessment of the lens and posterior segment of the eye (vitreous and chorioretina).

The direct ophthalmoscope is essentially a co-axial light source with a series of different power (diopter) lenses on a rotating wheel that can be positioned in between the user’s eye and the horse’s eye. The lenses are either convex (converging) lenses which focus the light beam closer to the ophthalmoscope or concave (diverging) lenses which focus the light beam further away from the ophthalmoscope. The convex lenses are shown by black (positive) numbers and the concave lenses by red (negative) numbers. The 0 diopter lens is a flat lens and does not bend the light beam, allowing the horse’s cornea and lens to focus the beam on the chorioretina. The 0 lens therefore provides a sharp focus image of the retina. Focusing up through the positive numbers brings structures anterior to the retina into view as follows:

<table>
<thead>
<tr>
<th>Lens diopter</th>
<th>Structure in focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Chorioretina</td>
</tr>
<tr>
<td>+1 – +7</td>
<td>Vitreous</td>
</tr>
<tr>
<td>+8</td>
<td>Posterior lens capsule</td>
</tr>
<tr>
<td>+8 – +11</td>
<td>Lens</td>
</tr>
<tr>
<td>+12</td>
<td>Anterior lens capsule</td>
</tr>
<tr>
<td>+13 – +15</td>
<td>Iris</td>
</tr>
<tr>
<td>+15 – +19</td>
<td>Anterior chamber</td>
</tr>
<tr>
<td>+20</td>
<td>Cornea</td>
</tr>
</tbody>
</table>

Users who wear glasses should remove them and adjust the lens dioptries according to their prescription as this will allow them to position the ophthalmoscope much closer to the horse’s head than if they leave their glasses on.

The direct ophthalmoscope can be used for distant direct ophthalmoscopy and close direct ophthalmoscopy.

In distant direct ophthalmoscopy the 0 diopter lens is used and the horse’s eye viewed from about an arm’s length away. The technique allows evaluation of pupil size and shape but is particularly good at identifying opacities between the surface of the eye and fundus as these are silhouetted against the tapetal reflex (reflection of the light beam back from the tapetum). It is particularly good at identifying cataracts.

Most examinations use close direct ophthalmoscopy. In this technique the ophthalmoscope is held as close to the horse’s eye as possible and different diopter lenses brought into play to allow visualisation of all parts of the eye. The technique is most suitable for posterior segment and fundus and, as noted below, slit lamp examination is the preferred method of assessing the anterior segment. The technique magnifies the image significantly (approx 80 times axially and 10x laterally) which allows detailed evaluation of the fundus but limits the amount of fundus that can be examined. Direct ophthalmoscopic examination of the fundus allows (at most) around 30–40% of the fundus to be examined and an axial view visualises at most 10% of the fundus. For this reason, indirect ophthalmoscopy is the preferred method of surveying the fundus as a much larger area can be visualised.

Indirect ophthalmoscope

This technique is carried out with a light source held close to the user’s eye and a lens held near the horse’s eye. Typically the light source will be at roughly arm’s length and the lens around 2–10 cm from the horse’s head. The technique takes a little practice and produces an inverted image of variable magnification (from around -1 to +20 depending on the diopter lens used). The technique can be performed simply and cheaply using a handheld transilluminator and a lens, which gives a monococular image. Better still, a binocular image is obtained when the user wears a headset with a light source and prism lens to direct the reflected image of the fundus into both eyes producing a stereo image. The advantages of the indirect ophthalmoscope are that a much greater field of view is obtained compared to the direct ophthalmoscope and is less affected by corneal and lens or opaque aqueous or vitreous humour.

Slit lamp

**Key points**

- The slit lamp is a binocular microscope which gives a 3D view of the eye
- It provides a stereoscopic view and so allows accurate location of abnormalities, including depth
- It is best suited to examination of the anterior structures of the eye and is the method of choice for detailed assessment of the cornea
Most examinations are carried out with the light beam set to a tall, narrow beam.

The portable (hand held) slit lamp is a microscope for the eye. The instrument is not commonly used in first opinion practice but is a really useful addition to the ambulatory veterinarian’s equipment and allows far more accurate assessment of the anterior parts of the eye than distant direct ophthalmoscopy or pen torches and transilluminators, especially if these are not used in combination with magnifying loupes. The slit lamp has 2 eyepieces giving a stereo image of the eye and it therefore allows the position and depth of abnormalities to be accurately determined. Like all microscopes, the slit lamp has different objectives (typically x10 and x16, possibly x25) which provide a magnified image, thus allowing more precise evaluation of lesions. The light beam can be varied in brightness and shape (height and width, allowing beam shapes from slit to circle) as well as colour. Most equine slit examinations are carried out using the white light source. The cobalt blue light source is useful for evaluating corneal ulcers stained with fluorescein. Most microscopes also have a green light filter which filters out red light and so makes blood vessels stand out as black structures against the background. There is limited application for this in the equine eye but can be useful. The position of the light beam relative to the instrument can also be varied so that the light beam can be aligned with the microscope or directed at an angle to it. In most examinations it is useful to have the beam angled relative to the microscope and to view the eye through a range of angles.

The slit lamp is useful for examination of the adnexa (lids and conjunctiva), cornea, anterior chamber, iris and lens. It is not useful for examination of the posterior segment (vitreous and the chorioretina). In equine practice it is particularly useful for evaluation of corneal foreign bodies (depth and position), corneal opacities (e.g. depth and position of nonulcerative keratopathies) and corneal ulcers (depth and evaluation of epithelial margins).

Before starting the examination, make sure the microscope is focused for your eyes using a piece of paper with printed text on it to focus the eyepieces. Adjust the position of the eyepieces so that crescents are not visible on the inside or outside edge of your field of view. The focal distance is close to the horse’s eye, typically 8–10 cm from the eye, and when starting to use a slit lamp it is useful to steady the lamp against your spare hand placed against the horse’s head. For examination of the eyelids and conjunctiva the lower power (x10) objective should be used with a wide, short light beam. To examine the cornea, anterior chamber, iris and lens the higher power (x16) objective should be used along with a tall, thin light beam. The angled thin bright beam of light provides a cross sectional view through the cornea which is invaluable when assessing the depth of corneal ulcers. When examining the right eye, start with the light beam set off to the left and vice versa for the left and then swing the light beam across the eye.
Use of ocular ultrasound

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Introduction

Ultrasonography can be used to examine the intraocular and retrobulbar structures in the standing horse. In a compliant animal, chemical restraint may not be necessary. However, conditions requiring further investigation using ultrasonography are often extremely painful such that sedation and possibly even regional anaesthesia is required.

Ultrasonography allows examination of the globe when there is opacity of the cornea, aqueous humour, lens or vitreous humour, or when there is extreme eyelid swelling preventing ophthalmic examination. In addition, it is useful in the further evaluation of intraocular masses or exophthalmus and for identifying foreign bodies. The most common indications are to evaluate for the presence of a retinal detachment after trauma, with uveitis and associated miosis to examine the posterior chamber, with hyphaema, when a cataract is present and with severe corneal opacities.

It is performed using ideally a 10 MHz transducer, but 5 or 7.5 MHz transducers will also produce good images. The transducer can be placed directly on the cornea or onto the closed eyelids. If the former method is used, a stand-off is required for examination of the anterior segment and topical local anaesthetic agents should be applied to the cornea. There are no set images that have to be obtained. The globes should be systematically examined in horizontal, vertical and oblique planes.

The normal eye comprises four major hyperechoic echoes: the anterior cornea, the anterior lens capsule, the posterior lens capsule and the retina/choroid/sclera. Additional echodensities that will also be visualised include the iris, corpora nigra, ciliary body, optic nerve and orbital muscles.

Ocular trauma

Penetrating trauma can result in a shallow anterior chamber, fibrin in the anterior chamber, hyphaema, lens capsule rupture, lens luxation/subluxation/expulsion, vitreous haemorrhage, retinal detachment and limbal or posterior scleral rupture. Blunt trauma can result in hyphaema, vitreous haemorrhage, lens luxation/subluxation/rupture and retinal tear/detachment. In such cases, ultrasonography can be used to measure identifiable structures i.e. globe size, anterior chamber depth and posterior chamber depth, look for haemorrhage and look for fibrin.

Intraocular masses

Intraocular masses can be neoplastic, cystic or inflammatory. They most commonly arise from iris and ciliary body. Ultrasonographically, cysts have echogenic walls and are fluid filled whereas neoplasms and inflammatory masses appear solid, hyperechoic, anechoic or heterogeneous.

Lens abnormalities

The normal lens has 2 distinct echodensities at anterior (convex) and posterior (concave) lens capsules. Abnormalities of the lens that may be detected ultrasonographically include:

- Cataract: Increased internal echoes within lens and increased visualisation of lens periphery, lens size may be increased
- Luxation or subluxation: normal lens position should be just behind the iris/ciliary body.

Posterior segment

The normal vitreous is anechoic. Abnormalities which may be detected ultrasonographically include:

- Degeneration: Creates interfaces that result in echodensities which appear as multiple variable echogenic lines
- Haemorrhage: Discrete to diffuse echoes which may demonstrate motion
- Inflammation: Multifocal, disconnected variable echodensities
- Retinal detachment: Can see retina distinct from choroid/sclera with separation of 0.5–1 mm. Appears as echodense linear structure, most often attached at optic disc and ora ciliaris retinae. Initially it may undulate, but chronically it becomes fixed. Should examine subretinal space, if the space appears anechoic then it is filled with fluid e.g. transudate whereas if it is filled with echodense material then this may be haemorrhage, inflammatory infiltrate or neoplasia.

Orbit

Indications for ultrasonographic examination of the orbit include exophthalmos and trauma. The differential diagnoses for exophthalmos include an orbital mass and haemorrhage. After trauma the retrobulbar space should be evaluated for displaced fractures, haemorrhage, swelling, optic nerve compression, and the integrity of posterior wall of globe.
Colours and shapes - where to start with making a diagnosis

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The examination of an eye in the horse is often faced with considerable trepidation. Not only are there serious concerns about rider safety but there is the added complication of the physical difficulty of actually getting a meaningful look at the eye. It has been said that there is more power in the eyelid of the horse with a painful eye than the biceps of the strongest human. This is surely true and is a major obstacle to the clinical examination of diseased eyes. However, modern practice has to some extent overcome the major difficulties with sedative and local motor and sensory nerve blocks. This means that there is in fact almost no excuse for not examining an eye thoroughly. However, it is invariably the case that the horse will resent handling and this will limit the ‘clinical return’ of an examination. There are some simple and helpful basic pointers that can be used to help in the diagnosis. These can to some extent be classified as variations in colour and shape.

Colour matters in equine ophthalmology! Obvious variations in colour, for example of the cornea, can be very helpful in establishing things that are wrong and to a large extent give an indication at least of the type of pathology involved. The clinician needs to have experience of the normal colours (or in the case of the ocular media - the complete absence of any colour). There are of course some natural variations that can in fact be quite startling to an inexperienced observer. For example the retina of an albino eye can appear very red - a bright light examination produces a ‘red’ reflection rather than the normal green-blue or green-yellow reflection. Furthermore, these eyes may have a marked variation in the pigments of the retina with an almost invisible retinal pigment epithelium and so choroidal vessels may be very obvious. In any ophthalmic examination, experience of what is ‘normal’ is very helpful. Individual variations in the normal state and a wide range of ‘normal variants’ add to the complexity. The first steps towards a diagnosis of eye disease require the clinician to ask ‘Is the eye normal or is it a normal variant?’ Once these 2 points have been answered negatively the clinician can then assume that the eye has pathology and then its significance has to be established. This will again involve interpretation of the colours and shapes of the various structures. For example, in acute uveitis the colour of the iris varies markedly in inflammatory conditions. The naturally patterned warm nutmeg brown colour of the iris can be changed to a uniform ‘muddy brown’ colour. Of course other aspects such as iris spasm (miosis) and even anterior chamber haemorrhage and inflammation may be present. In the former case there will be a red colour often with an accumulation of blood in the inferior/inferior part of the anterior chamber. In the latter case the accumulation will be reflected as a yellow-grey accumulation and often an accompanying white or grey ‘flare’ in the aqueous, which can be rapidly identified by use of a slit lamp biomicroscope.

Changes in colour of the cornea are a very useful aids to diagnosis. Here a blue colour is associated with corneal oedema, white with cellular infiltration and scarring, yellow with inflammatory debris and red with blood (usually blood vessels). The presence of a black circular area in the cornea should alarm the clinician immediately since that might reflect exposure of the iris and absence of the cornea down to Descemet’s membrane. A green or brown colour can reflect variations in inflammatory responses typical of either immune mediated keratitis or fungal infections. Changes in the colour of the vitreous compartment are associated with haemorrhage (red at first, becoming brown later) or inflammation (often grey or sometimes greenish).

Colour changes in the lens usually reflect the presence of lenticular opacity (cataract) and whilst most are grey/white in colour variations do occur. The major point about changes in colour of any of the ocular media is that they usually result in inability to look through them clearly to the deeper structures. Cataracts also vary in shape and location and those are also important points to notice since some are mild and nonprogressive and others are much more dangerous, progressive and functionally limiting.

Changes in shape of the various structures are also helpful. The normal iris of the horse is a horizontal oblong. Variations in shape occur with some congenital abnormalities such as iris hypoplasia, coloboma and persistent pupillary membranes. Traumatic injuries commonly result in some iris changes with adhesions to the lens (posterior synechiae) or the corneal endothelium (anterior synechiae). An acquired abnormally shaped iris should always alert the clinician to the possibility of previous uveitis - whether that was result of trauma or immune-mediated disease or infection.

Possibly the most challenging variations in colour and shape occur in the retina and optic papilla. The wide variations in normal colour should not divert the clinician from establishing the difference between normal/normal-variant and pathology. Variations in the shape and colour of the optic papilla in health and disease can be subtle - even minor changes can reflect serious compromising pathology whilst again there are many individual variations in both shape and colour in normal horses - or at least those we take to be normal because they have no detectable visual deficits. A coloboma of the retina is usually distinctive in its location and complete absence of any retinal tissue. This developmental disorder may be visually insignificant but a similar area of retinal degeneration can be critical. Evidence for retinal degeneration is usually manifest as an attenuation of the vascular structures running towards the area and a mixture of dark and light pigmented areas giving it a blotchy appearance. In the same way deposition of the red-brown pigment lipofuscin in the retina may be an indicator of motor neuron disease.

The variations in colour and shape of ocular structures is very helpful in interpreting pathological and incidental changes in the equine eye and clinicians should be attuned to these so that all helpful information can be collected to make a diagnosis - even if nothing can then be done about most of the structures!

Further reading

I often think how lucky we are to work in an era of such great change and dramatic improvements in knowledge and equipment. When I graduated there was much mystery about the inner workings of the mare and her oestrous cycles. Some of this was encouraged by our profession as we examined the mare with furrowed brow and slightly arched back and a look of great concentration while pronouncing a clinical judgement. Much of it was a genuine lack of knowledge. Ultrasonography enlightened us, dispelled many myths and also gave us control of many of the reproductive processes. Ultrasonography has also enabled the nonprofessional to be actively involved in breeding and management decisions. Assisted reproductive techniques (ART) and pharmacological developments have improved reproductive efficiency of horses to a level not seen in other domestic species. Despite these technological advances, it is still fair to say that the most important aspect of fertility is management.

Artificial insemination
The collection of semen and artificial insemination (AI) of mares has fascinated breeders and researchers for centuries and the horse was the first species in which it was practised. The technique has become routine on many breeding farms. However, not all breeds embrace AI and one of the largest breed registries in the world, the Thoroughbred, still bans registration of foals produced with artificial techniques (AI, embryo transfer etc.). A stallion mating naturally 4 times per day can still not cover as many mares in a week as a stallion being collected only 3 times per week and the mares inseminated artificially. Advantages of AI are a reduction of injury to people and horses and an improvement in disease control. In addition more mares can be inseminated from a single ejaculate, mares remote from the stallion can be inseminated and semen can be routinely evaluated. A potential disadvantage of AI is that when it is improperly practised fertility may be reduced.

Cooled transported semen
Although the Arabs may have practiced AI in both horses and humans before the birth of Christ, the first real work in this area was carried out by Spalanzani around 1776. He found that by placing stallion semen in the snow he did not kill the ‘spermatic vermicules’, but merely made them inactive; upon warming, their motility returned. It took centuries to exploit this finding and, contrary to popular belief, it was the bovine industry that developed a commercial application for cooled transported semen prior to successful cryopreservation. Cooled transported semen is firmly entrenched and recognised throughout the world by various horse breed societies and the technique is becoming more popular. In Standardbreds and Quarter Horses in North America and Australasia and in the Warmblood breeding industry in Europe, cooled transported-semen programmes form the basis of their breeding industries.

Frozen semen
Cryopreservation of spermatozoa remained an enigma until the serendipitous discovery of glycerol in 1948:

“In the autumn of 1948 my colleagues Dr Audrey Smith and Dr C Polge were attempting to repeat the results which Shaffner, Henderson and Card had obtained in the use of laevulose solutions to protect fowl spermatozoa against the effects of freezing and thawing. Small success attended the efforts and pending inspiration a number of solutions were put away in the cold store. Some months later work resumed with the same material and negative results were again obtained with all of the solutions except one, which almost completely preserved motility in fowl spermatozoa frozen to -79°C. This very curious result suggested that chemical changes in the laevulose possibly caused or assisted by the flourishing growth of mould which had taken place during storage had produced a substance with surprising powers of protecting living cells against the effect of freezing and thawing. Tests however, showed that the mysterious solution not only contained no unusual sugars but in fact contained no sugar at all. Meanwhile further biological results had shown that not only was motility preserved after freezing and thawing but, also, to some extent, fertilizing power. At this point, with some trepidation, the small amount (10–15 ml) of the miraculous solution remaining was handed over to our colleague Dr D Elliott for chemical analysis. He reported that the solution contained glycerol, water and a fair amount of protein. It was then realised that Mayer’s albumen - the glycerol and albumen of the histologist - had been used in the course of morphological work on the spermatozoa at the same time as the laevulose solutions were being tested and with them had been put away in the cold store. Obviously there had been some confusion with the various solutions although we never found out exactly what had happened. Tests with new material very soon showed that the albumen played no part in the protective effect, and our low temperature work became concentrated on the effects of glycerol in protecting living cells against the effects of low temperature.”


Since the discovery of the protective effects of glycerol during freezing and thawing, progress has been dramatic in the area of gamete preservation in many species. In addition, other agents such as DMSO and amides, have been demonstrated to be useful for freezing horse spermatozoa. However, there is still room for considerable improvement in the efficiency of the techniques. For example, currently it is estimated that only 30% of stallions produce spermatozoa that freeze well, 30% have spermatozoa that does not survive freezing at all (from a commercial standpoint) and 40% have semen that, when using different media and cooling/freezing curves, can be frozen with close to acceptable post thaw parameters. In addition the average pregnancy rates per cycle from frozen-thawed stallion
spermatozoa are still only around 50% of those achievable using fresh semen.

**Embryo transfer**
The commercial development of equine embryo transfer (ET) has lagged behind other domestic species like cattle, sheep and pigs due to the limitation of one embryo transfer per year imposed by most of the major breed registries. In 2002 the American Quarterhorse Association (AQHA), acting on legal advice, withdrew the rule limiting the number of embryos transferred per mare per year and retrospectively allowed registration of multiple ET-derived foals. This had a significant effect on the numbers of ET's requested and, indeed, the very nature of restraint of trade laws is likely to have other ramifications, such as the current legal challenge in Australia to the ban on artificial insemination (AI) in the Thoroughbred.

Embryo transfer originally was most widely used in the older mare that fails to get pregnant or conceives, establishes a pregnancy and then undergoes early embryonic death (EED) or abortion. This limited the technology as these mares are less likely to provide embryos for transfer than normal, reproductively healthy mares. This was followed by a rapid adoption of the technology in Argentina and Brazil for use in Polo ponies. ET is used widely nowadays in performance mares (Quarter Horse, Standardbred, showing, Polo, Arabian, Warmblood etc) together with newer technologies such as frozen semen, low dose insemination and other ART's such as oocyte transfer and intracytoplasmic sperm injection (ICSI). Use of these techniques places pressure on researchers to develop reliable methods for superovulation, and cryopreservation of larger embryos (Days 7 and 8) and even oocytes. ET can be performed on yearling or 2YO fillies as a means of getting them into production earlier than traditional breeding. In addition ET has been used to produce offspring from endangered equids such as the Przewalski's horse and the Poitou donkey.

Embryo Transfer will be discussed under the following headings:
- Management of donors and recipients
- Factors that affect embryo recovery

Relevant technological advances will be discussed under the following headings:
- Cooled transported embryos
- Freezing embryos
- Semen cryopreservation
- Oocyte cryopreservation
- Superovulation
- Embryo bisection
- Oocyte retrieval (OPU)
- Oocyte maturation (IVM)
- Oocyte transfer and GIFT
- Intracytoplasmic sperm injection (ICSI)
- In vitro fertilisation (IVF)
- Nuclear transfer (cloning)
- Embryonic stem cells
- Low dose insemination
- Sex selection of spermatozoa

We are clearly fortunate that these developments usher in an exciting new era in reproductive techniques. Already we can obtain foals from sex-selected frozen-thawed spermatozoa of OPU and IVM oocytes, fertilised by ICSI and freezing the embryos after in vitro culture and prior to transfer. These techniques allow us to extend the reproductive work of the equine veterinarian and scientist throughout much of the nonbreeding season for the horse.

**Post script**
Due to the extensive size of the Plenary lecture material a copy of the paper will be available for download at http://www.beva.org.uk/congress/Congress2010/ScientificProgramme
There is currently a debate taking place in Europe on the patentability of embryonic stem cell cultures. This debate turns upon the more general question of the morality of stem cell technology. Dr Justin Turner is uniquely qualified to comment on the issues surrounding assisted reproductive technologies, having graduated from RVC in 1986, obtained a PhD in immunology in 1990 and been practising as a barrister since 1992. He sits on GTAC a government advisory and ethics committee on gene transfer and stem cell technology. Dr Turner’s presentation will describe the legal and moral issues which have arisen in this debate and the political context in which they arise.

NOTES
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Next Congress:

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Corneal surgery often begins with basic superficial keratectomy to excise inflamed, infected, necrotic or neoplastic tissue. This may be followed by a conjunctival graft, or corneal graft in combination with aggressive medical therapy to manage complicated corneal ulcers. Corneal surgery will also include repair of corneal lacerations, both penetrating and nonpenetrating.

Corneal surgery is typically performed under general anaesthesia to optimise the outcome although on occasion a superficial keratectomy may be done in a standing horse. Magnification, using surgical loupes or an operating microscope, is essential for all corneal surgery. In general 2.5x to 5x is the magnification required for most corneal surgical procedures. Topical anaesthesia, a retrobulbar nerve block and use of a nondepolarising neuromuscular blocker in addition to general anaesthesia are all tools to facilitate outcome and surgical exposure.

A superficial keratectomy provides a biopsy for histopathological examination and culture, debrides and debulks damaged and infected corneal stroma, and provides a bed to transplant and suture a conjunctival or corneal graft to. A No. 64 Beaver blade is commonly used, first outlining the area to be excised, then undermining and removing the affected area of cornea. In general, 50–70% of the corneal thickness can be removed, but excision of 50% or more is an indication to reinforce the remaining cornea with a conjunctival or corneal graft. Thickness of the normal equine cornea is approximately 1 mm, being thinnest centrally. The cornea will increase in thickness with disease as a result of oedema, cellular infiltration, vascularisation and scar formation.

Conjunctival grafts include advancement, hood, bridge, pedicle and complete conjunctival grafts. The author’s preference is to perform a rotational conjunctival pedicle graft for most focal corneal ulcers/abscesses using the other types for more extensive lesions. Prior to placement of a conjunctival graft, debridement of the affected cornea by superficial keratectomy is indicated. Dorso-temporal bulbar conjunctiva is mobilised leaving an intact blood supply. An attempt should be made to appose conjunctival and corneal epithelium at the edge of the graft and to place 7-0 to 8-0 Vicryl® sutures two-thirds depth into healthy cornea. A continuous suture pattern, double or single is preferred. Conjunctival grafts adhere to the underlying exposed corneal stroma providing blood supply and cells required to repair and rebuild the damage cornea. Opacification of the graft site will occur, but is generally less than would have occurred without surgery. Opacification can be minimised by trimming the graft, severing its blood supply, 6–8 weeks following the initial surgery.

Autologous and homologous lamellar corneal grafts, corneal-scleral transposition, and penetrating keratoplasty are more involved techniques reserved for the most severe of corneal ulcers or for perforating corneal lesions.

Nictitating membrane or third eyelid flaps are of little or no benefit in the management of complicated and infected equine corneal disease and are, in many instances, contraindicated.

Following surgery, excised tissues are submitted for histology and bacterial and fungal culture as indicated. Medical therapy will include antimicrobials, mydriatics and systemic NSAIDs. When corneal penetration is required the flouroquinolones offer a broad spectrum of activity with excellent penetration. Topical voriconazole would be the antifungal of choice. To ensure delivery of medication, placement of a subpalpebral lavage system may be required. Of the subpalpebral options, the Mila® system (http://milainternational.com) is the best option in the author’s opinion.

Further reading
Why is equine intra-ocular surgery feared - is it paranoia or is the fear justified?

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Although intraocular surgical techniques have been practised in the horse for several hundred years, it has always had the reputation for being fraught with difficulty. The results of ‘couching’, a historical procedure to relieve blindness due to cataract that involved posterior dislocation of the lens, were undeniably bad (even with the scanty available records), the poor outcome was possibly associated with the development of severe uveitis and haemorrhage. Possibly the single most important influence on prognosis is ‘CASE SELECTION’. Most eyes presented for intraocular surgery have had serious ocular disease! These are bad surgical cases no matter how tempting the case may be - indeed this might have been the reason for the surgery in the first place.

For example, a surgeon may be tempted to remove a cataract from a chronic uveitic eye with extensive iris adhesions and active inflammation because the horse is blinded as result. The logicality of the intention belies the difficulty of the procedure. Forty years ago, it was said that opening an eye of a horse was ‘a precursor to enucleation’ but that is far from the case now. There has been enormous progress, largely driven by a few intrepid individuals such as Dennis Brooks, Brian Gilger, Uwe Heidbrink and David Wilkie and the increasing numbers of successful cases is testament to their determination and their willingness to share their expertise.

In the event that a client is being appraised of the risks of intraocular surgery there are some definite warnings that should be given! Firstly, the horse is probably more sensitive to intraocular interference than many other species; the eye could be aid to be ‘uveitogenic’ and this could be seen as an excuse for failure due to inadequate surgical technique but this is not a fair assessment. Secondly, there is an inherent incompatibility between the size of the eye and many of the standard instruments that are available for intraocular surgery. For example Utrata forceps and Vannas scissors designed for human or canine use are far too short for the horse and manufacture of dedicated instruments is difficult and very expensive. Similarly, all currently manufactured phaco probes are limited to 1 cm length and this makes lens removal much more problematic - a bimanual method with nuclear division/splitting may be essential. Remaining with the lens, most equine cataracts are presented in an advanced stage even when they are nonuveitic! Capsulorhexis can be problematic in cases where there is capsular thickening and deeper attachment to the lens so different techniques may have to be used. Heat generated at the corneal/limbus incision during phacoemulsification of a mature cataract means that healing of the sites can be problematic. Even the normal anatomy can be a problem - for example large granulea indica may restrict access to the iris or the lens capsule.

Analysis of cases of failed eye surgery is difficult because no-one wants to publish the failures as opposed to the successes but anecdotal reports from even the very best surgeons in the modern world confirm that there is still a significant failure rate and that overall this is probably higher in horses than any other species. Admittedly there are increasing literature reports in refereed journals that constructively include failure rates and complications and this is helpful in identifying measures that will improve outcomes.

Historically probably the most serious ocular disease in the horse is immune-mediated persistent uveitis. Over the last 15 years the option of partial vitrectomy as a treatment for some forms of immune-mediated uveitis has been developed. The procedures were historically commonly complicated by severe uveitis, retinal detachment, cataracts or lens dislocation. There appears to be a significant difference in the outcome and complication rate between surgeons in Germany and those in USA in particular; the former report very few complications whilst the latter report far more. However, as experiences are shared in an open forum of honest reporting of results, the procedure is gradually becoming more predictable.

The sophistication of intraocular instrumentation in the human and canine field can be exploited in equine surgery but the transposition of techniques takes a certain degree of courage and a new breed of intrepid ophthalmic surgeons. Training must be undertaken - self learning is a painful and often depressing process that in the modern world is not either necessary or satisfactory. A good example of this is the use of endolasers to treat glaucoma in small animals and humans. So far there is no advice as to whether this technique can or should be explored in horses. The ease of enucleation or exenteration and the manner in which horses adapt so well to a single eye means that expensive procedures with a significant/high risk of failure and no ‘clinically defensible evidence base’ bias most practicing veterinarians towards those techniques or benign neglect (in case of nonpainful ophthalmic disease). It may be better to remove the eye - even if it is blind and painless rather than attempt surgery and leave the horse with a persistently painful sighted eye.

The application of modern ophthalmic surgical techniques using microsurgical methods has vastly improved the options for some intraocular techniques. Endoscopic systems that illuminate the posterior segment via a portal of insertion in the pars plana can allow vitrectomy to be carried out.

Before embarking on any ocular surgery whether intraocular or not the surgeon should ensure that they are comfortable with the equipment they have (magnification is essential, whether by Loupe or microscope) and that they are fully conversant with the microsurgical instruments required. Intraocular procedures performed without appropriate instruments carry significantly increased risks of catastrophic failure. The methods used to address some of the problems are largely extrapolated from the human and canine experience but many of these do not really apply to horses! This should not deter us from performing procedures but it is probably sensible that cases should be referred to centres with equine ophthalmic experience since the biggest factor involved is the surgical ability and experience of the operator! Experience is, however, usually something that you get half an hour after you needed it! It seems sensible in the long term to have a limited number of properly equipped centres with experienced staff but even in those conditions, complications will be encountered. We need much more research and many more cases if the prognosis is to be improved significantly. There is little worse than having to perform a complex intraocular procedure once every 2–3 years! In the human ophthalmic surgery specialty ‘solo’ surgery is not permitted until a trainee surgeon has assisted in several hundred cases (and often several thousands) and registrars have access to structured training. The veterinary
profession has few restrictions on what individuals undertake and of course extremely limited formal training opportunities. Residencies in veterinary ophthalmology are rare. Unless and until there is a much better development programme we will inevitably be left in a position where we will have to ‘have a go’ … if it were my eye, I would not like to hear the surgeon saying that!

Further reading


Equine adnexal surgery

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The first decision in equine adnexal surgery is whether to perform the procedure as a standing surgery or to use general anaesthesia. Knowledge of regional motor and sensory nerve blocks and the technique for performing a retrobulbar nerve block are essential. Regional anaesthesia of the auriculopalpebral branch of CN VII and the supraorbital (frontal) branch of CN V provide akinesia and anaesthesia of the superior eyelid, respectively. The auriculopalpebral nerve is blocked by injection at the intersection of a line parallel to the caudal aspect of the ramus of the mandible and a line parallel to the dorsal aspect of the zygomatic arch. Using a 25 gauge 5/8 inch needle 3–5 ml of mepivacaine HCl or similar agent is injected. The supraorbital nerve is blocked as it emerges from the supraorbital foramen of the frontal bone. This foramen is palpated, a 25 gauge 5/8 inch needle is inserted into the foramen and 2 ml of mepivacaine HCl is injected, another 1–2 ml is infiltrated subcutaneously as the needle is removed. Additional sensory nerves, which may be occasionally anaesthetised, include the infratrochlear, lacrimal and zygomatic branches of CN V. Alternatively, local infiltration of anaesthetic can be used to provide anaesthesia of a specific area such as a region of the eyelid or third eyelid. A retrobulbar block uses a 75–100 mm spinal needle inserted posterior to the arch of the frontal bone and directed ventrally. The needle is inserted intraconally and 7–10 cc of mepivacaine is injected. As the needle is advanced, it contacts the dorsal muscle cone and the globe will deviate dorsally. The needle is then advanced through the dorsal muscle cone to the intraconal space. The surgeon should allow 10–15 min for effect. Following a retrobulbar block the head should be kept elevated for 1–2 h to prevent dependant swelling and pain and should be administered prior to surgery and a line parallel to the caudal aspect of the ramus of the mandible

The nasolacrimal apparatus consists of the superior and inferior puncta and canaliculi, nasolacrimal sac, nasolacrimal duct and nasal punctum located on the floor of the nasal vestibule. Examination of the nasolacrimal system includes placement of fluorescein stain in the conjunctival cul-de-sac and observing its appearance at the nasal opening, irrigation of the nasolacrimal system, and radiographic and CT imaging. Irrigation of the nasolacrimal system can be performed from the eyelid punctum or the nasal punctum. Topical anaesthetic is applied to the eye and an open-ended feline urinary catheter is placed in the superior punctum. Sterile eyewash or saline (10–20 ml) is used to irrigate the system, observing fluid passing out both the inferior punctum and the nasal punctum. If irrigation is performed from the nasal punctum a No. 5 or No. 6 French or a feline urinary catheter is used and the volume of irrigating solution increased. Radiographic imaging of the nasolacrimal duct, dacryocystorhinography, can be performed using contrast material injected into the duct from the superior eyelid punctum. CT scan will allow visualisation of the nasolacrimal system. Abnormalities of the nasolacrimal system can be congenital or acquired. In the horse the most common congenital abnormality is atresia of the nasal punctum, which results in epiphora at 3–4 months of age. Additional abnormalities include atresia of an eyelid punctum, abnormal placement of an eyelid punctum and multiple nasal openings.

Use of systemic NSAIDs will help to minimise post operative swelling and pain and should be administered prior to surgery whenever possible.

Further reading


The equine stifle is host to a wide range of conditions causing lameness. A combination of clinical examination, lameness evaluation, diagnostic local analgesia, radiography and ultrasonography is required as a minimum in the detection of stifle pathology. Additional diagnostic aids such as arthroscopy and computed tomography may be employed if further information is required. In all cases a thorough understanding of the complex anatomy of the stifle is essential.

Anatomy
The stifle comprises 3 compartments - the medial and lateral femorotibial joints and the femoropatellar joint, formed by the trochlear groove of the femur and patella. The medial trochlear ridge is more prominent. Cranially, there are 3 patellar ligaments (medial, middle and lateral). The centre of the tibial plateau forms the intercondylar eminence comprising 2 prominences (medial and lateral intercondylar tubercles). The medial and lateral femorotibial joints are formed between the medial and lateral tibial and femoral condyles. These are separated by the crescent shaped menisci. The axial aspects of the menisci are intrasynovial, the joint capsules attaching to their abaxial aspects. The superficial and deep parts of the medial collateral ligament course within the capsule, also having attachment to the medial meniscus. The lateral collateral ligament is similar, and attaches in part to the lateral meniscus but is separated from it by the tendon of origin of the popliteus muscle, which also separates the ligament from the lateral femoral condyle. Unlike its medial counterpart distension of the lateral femorotibial joint is not easily palpable due to the overlying biceps femoris separating it from the skin laterally. The 2 cruciate ligaments are extrasynovial between the medial and lateral femorotibial compartments.

Radiography and ultrasonography of the stifle
Sarah E. Powell
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Ultrasonography
Examination of the superficial parts of the stifle is possible with 7.5 MHz rectal probe. A more involved examination of the cranial, lateral and medial aspects of the stifle requires a 6–15 MHz linear probe for superficial parts and a 3.5–5 MHz curvilinear or sector for depth of the femorotibial joints (cruciate ligaments, meniscotibial ligaments) and the caudal aspect. Preparation is key with extensive close clipping from flank fold to just distal to the tibial tuberosity (extending the entire circumference of the thigh if the caudal aspect is to be examined). Copious amounts of coupling gel should be allowed to penetrate the skin for 10 min to improve image quality. Stand-offs are not always necessary but allow alignment more easily with fibres in the ligamentous structures and may be needed in lightly muscled horses particularly those with no distension of the joints.

Radiography
For routine examination views should include lateromedial (LM), caudocranial (CaCr), and lateral oblique (caudo60°lateral-craniomedial oblique) views. Additional views may be required in some cases - flexed lateromedial and cranioproximal-craniodistal oblique (patellar skyline) views. Suggested equipment includes an x-ray unit with minimum output of 90 kV and 20 mAs. Digital systems or rare earth screens are recommended and a grid may be necessary due to soft tissue thickness. Large plate size (35 x 43 cm) is required to visualise sufficient length of the femur and tibia.

A full abstract for this lecture, including references, is available to download at www.rossdales.com
Meniscal and ligament injuries of the stifle

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Meniscal and ligament injuries are a frequent cause of stifle lameness in the horse. Meniscal and cruciate lesions were the primary diagnosis in 201 of 639 stifle arthroscopies in the author’s series. Other ligament injuries in the stifle include those of the medial collateral and patellar ligaments.

Diagnosis

Clinical signs of swelling and obvious joint pain are not frequently manifest in milder soft tissue injuries in the stifle and diagnosis of the site of lameness will often depend on diagnostic analgesia. Lameness is usually worsened by flexion of the upper limb but differentiation by manipulation tests is unrewarding. The different structures within the joint do not manifest specific signs when injured so radiography and ultrasonography should be performed once the stifle is established as the site of pain. Radiography is most useful in the chronic case. Ultrasonography is important for the specific diagnosis of medial collateral and patellar ligament injuries but has limitations when diagnosing meniscal and cruciate lesions because of artefact and accessibility problems. For these, in the absence of MR imaging, arthroscopy offers the most accurate diagnostic information.

General management

Stifle lameness that presents without radiographic or ultrasonographic changes, and therefore no specific diagnosis, is probably best treated with stable rest and intra-articular medication followed by re-evaluation in 6 weeks. If lameness has resolved, controlled exercise should commence but if there has been no improvement an arthroscopic investigation is indicated. If a meniscal or cruciate ligament injury is suspected radiographically or ultrasonographically at the outset, or if the injury is severe, arthroscopy may be indicated at the first examination.

Meniscal injuries

Clinically these do not differ from most other stifle lamenesses. Some meniscal and meniscal ligament injuries may be diagnosed ultrasonographically (Hoegaerts et al. 2005) but the clinician should be wary of false positive and false negative findings. Arthroscopic evaluation of the lesion is indicated. Loose tissue can be debrided and the joint evaluated for concurrent damage. Loose tissue can also be aspirated and the site of lameness will often depend on diagnostic analgesia. Of 126 meniscal injuries diagnosed arthroscopically at the author’s hospital, 80% involved the medial meniscus and there was concurrent articular cartilage damage in 96 horses. The progression was statistically worse if the lesion was severe, if there were radiographic signs or if there was concurrent articular cartilage damage (Walmsley et al. 2003). The most frequent radiographic sign was new bone formation on the medial intercondylar eminence of the tibia (MICET) and this was much more frequently seen than with cruciate injury. Rehabilitation involves 6 weeks’ stable rest with incremental hand walking exercise followed by 4 months’ rest in a small pen and no free paddock exercise until the horse has returned to full work. Overall 62% of mild and moderate cases and 10% of severe cases treated arthroscopically returned to full work.

Cruciate ligament injuries

Rupture of the cranial cruciate ligament (CrCL) in the horse is a devastating injury and usually warrants euthanasia. It is characterised by severe swelling and pain in the stifle. Less severe injuries are clinically similar to meniscal tears. As with these latter, mild cruciate injuries may go undiagnosed and this discussion is confined to those diagnosed at arthroscopy. Even experienced ultrasonographers have difficulty diagnosing cruciate lesions so the diagnosis usually depends on arthroscopy. In the author’s series, 72 cases involved the CrCL and only 4 involved the caudal cruciate ligament (CaCL). Most CrCL lesions were located mid body. Debridement of loose tissue is performed. Repair of ruptured CrCLs in horses has not been reported. Again concurrent damage can have a significant influence on the outcome as does the presence of radiographic change. In the author’s series, excluding horses with rupture of the CrCL, 33% of severe injuries recovered and 61% of horses with mild or moderate lesions returned to use.

Medial collateral ligament injuries

The medial collateral ligament is more commonly affected. Complete rupture manifests as acute, severe lameness with swelling and pain over the ligament and instability of the joint when the distal limb is abducted. Caudocranial stress radiographs with the limb abducted reveal the instability. Sprained ligaments often show few specific clinical signs but there may be heat, pain and thickening over the ligament in some cases. Flexion tests are usually positive but intra-articular analgesia of the medial femorotibial joint is often negative. Ultrasonography should confirm the diagnosis and radiography is useful in chronic cases that have developed changes at the origin and insertion of the ligament. Scintigraphy can also be a useful diagnostic aid. Horses with sprained medial collateral ligaments should be given anti-inflammatory drugs rested for 6 weeks and then start a controlled exercise regime if all is well. The prognosis is poorly documented but anecdotally it is considered poor if enthesophages changes develop radiographically. The prognosis for ruptured ligaments is very poor. Repair has been attempted but is fraught with complications.

Patellar ligament injuries

These are infrequently diagnosed. The middle patellar ligament is most commonly injured and in some cases there may be an association with previous patellar ligament desmotomy.

Lateral ligament injuries have also been reported (Dyson 2002). Localising signs may be absent but femoropatellar effusion, periarthritis thickening, or oedema may occur in some cases. Intra-articular analgesia of the femoropatellar joint is often negative and diagnosis may depend on ultrasonographic findings. Scintigraphy may show increased radiopharmaceutical uptake. Six months’ rest is advocated and slow resolution of the lameness with occasional recurrence has been reported (Dyson 2002).

References


Management of medial femoral condyle OCL’s - enucleation vs. injection?

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Management of medial femoral condyle osteochondral lesions (OCL; aka subchondral bone cysts) should encompass medical, surgical and rehabilitation therapies. Proper management requires an accurate diagnosis including intra-articular anaesthesia and radiographs as a minimum. A minimum of 3 radiographs should be obtained (Ca-Cr, lateral, Calat-CrMed projections) to ascertain the 3D configuration of the OCL. OCLs can be primary in origin, or secondary to osteoarthritis (OA). Lesions can be bilateral, so both femorotibial joints should be radiographed. Horses with advanced OA, as indicated by osteophyte formation on the proximal-medial tibia and distal-medial femur, a joint space narrowing and mineralisation of the menisci, were previously not considered candidates for surgery. However, newer biological grafting techniques are beginning to challenge this paradigm.

The majority of surgical treatments for OCL and cartilage lesions have centred on arthroscopic enucleation or removal of the necrotic tissue and debridement to healthy underlying subchondral bone. Other treatment options include corticosteroid injection into the cyst lining and cartilage grafting procedures.

Arthroscopic enucleation

The first retrospective describing arthroscopic debridement of OCL was from Howard et al. (1995). Complete follow-up information was obtained for 39 horses; 22 (56%) had a successful result and 17 (44%) had an unsuccessful result. In a separate analysis excluding horses with unsuccessful results because of factors not directly attributable to the subchondral cystic lesion of the medial femoral condyle, 23 of 31 (74%) horses had a successful result and 8 of 31 (26%) had an unsuccessful result. Quarter Horses had a less than typical favourable outcome, but the numbers were small. Clinical impression prevailed that horses greater than 2 or 3 years of age, large breed horses and upright horses such as western performance horses, did not do as well as young Thoroughbreds. Smith et al. (2005) nicely supported some of these clinical impressions in a study where horses were separated by age and found that older horses (>3 years) were less likely to return to soundness (P = 0.02) or to work (P = 0.04) than younger horses (<3 years). Of 39 horses age 0–3 years, 25 (64%, 95% CI 49–79%) returned to soundness. Of 46 horses age >3 years, 16 (35%, 95% CI 21–49%) returned to soundness. In addition, cartilage damage at sites other than the OCL negatively affected prognosis (P = 0.05).

Intralesional corticosteroid injection

Injection of corticosteroids into the lining of OCLs is gaining in popularity. The potential advantages of this technique include a shortened duration of anaesthesia and perhaps less disruption of the articular cartilage covering the OCL opening; however, the amount of cartilage removed in simple debridement procedures is surgeon-dependent. Early clinical impressions are favourable and have been reported by Wallis et al. (2008). Thirty-five of 52 (67%) cases were classified as successful involving 73 SCLs of which 56 (77%) were classified as successful. These results appeared comparable to those reported by Howard et al. (1995). In the study by Wallis et al. (2008), there was no significant association between age group (age ≤ 3 vs. >3 years) and outcome, or cyst configuration and outcome. Similar to the study by Howard et al. (1995), upright, western breed horses had a decreased chance of success. The disparity in age-associated outcomes between the Smith and Wallis study is unclear, but could be due to age-distribution where more of the horses in the Wallis study were equal to or closer to 3 years of age than in the Smith study. In addition, the breed distributions were different with Thoroughbred and western performance horses predominating the Wallis study and Warmblood breeds primarily representing the Smith population. Many clinicians inject OCL using ultrasound guidance, but there are no comparative studies available to determine if this is as effective as arthroscopic application of intralesional corticosteroids.

Articular cartilage grafting procedures

For upright horses, aged horses and those with arthritis of meniscal lesions, treatment in addition to enucleation seems warranted. Several iterations of articular cartilage grafting procedures have been performed at Cornell University (Nixon and Fortier). The grafts have been biphasic in nature and have progressed from use of cancellous bone to B-TCP or HA-TCP bone substitutes in the base of the defect covered with cartilage grafts including neonatal chondrocyte/autologous fibrin/insulin-like growth factor-I, mesenchymal stem cells/autologous fibrin, or bone marrow concentrate. Recently Ortved et al. (2009) reported on 48 horses and 65 SBCs treated with arthroscopic cyst debridement followed by filling of the cyst with either autogenous cancellous bone (44 horses) or tricalcium phosphate (3 horses) and covering with algogenic chondrocytes/fibrin/IGF-I with 3 years’ follow-up. A successful outcome was achieved in 35/47 horses (75%) while 43/47 horses (91%) were improved following surgery. These results suggest that growth factor enhanced chondrocyte grafting may improve repair of OCLs in mature horses and those with early osteoarthritis through superior cartilage resurfacing.

Post operative rehabilitation

Regardless of the therapy applied, a controlled exercise programme with regular radiographic recheck examinations is required. Clients must be clearly informed that any stage might be prolonged based on the outcome of recheck examinations. Progression from one level of exercise to the next is based primarily on formation of a subchondral plate across the defect.

References


Management of upward fixation of the patella

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Upward fixation of the patella is a well recognised problem in equine practice. When the stifle becomes ‘locked’ the upper limb is fixed in extension and due to the reciprocal apparatus the lower limb is also extended. This may result in anything from subtle transient or intermittent signs of gait abnormality, through to more marked fixation of the limb, in a typically extended ‘trailing’ position. Most often the horse or pony manages to ‘unlock’ the fixation, although on rare occasions this may be a permanent disabling problem, where urgent veterinary intervention is required.

The condition has been reported in most breeds and types, and is more common in younger animals and miniature breeds. A huge diversity of treatment and management options have been suggested. These include simple practices such as increasing the level of exercise and carrying out corrective trimming and shoeing, through to medical treatments ranging from injection of anabolic steroids systematically through to injection of irritant solutions into the medial patellar ligament, through to surgical treatments including desmotomy of the medial patellar ligament, and splitting of this ligament in its upper third.

Where multiple treatments exist for any single condition, it is clear that no one treatment is universally successful. Most often conservative and nonsurgical methods are tried first and where these prove to be unsuccessful, surgery may be carried out.

Medial patellar ligament desmotomy is the most commonly performed surgery to relieve this condition. Although this is a relatively simple procedure which can easily be carried out under standing sedation and local anaesthetic, it is not without risk. Immediate complications at the time of surgery include haemorrhage and joint penetration. Post operative infection and fibrosis have also been reported. In the longer term the possibility of remodelling and even fragmentation of the distal patella has been recognised, and can be a problem. This is most likely to be a response to altered mechanical forces on the patella, resulting in instability.

Where conservative measures fail, the author’s preferred choice is to carry out a medial patellar ligament desmotomy. This technique will be discussed and other techniques debated. Post operative management advice following patellar ligament desmotomy varies hugely between surgeons and this will also be highlighted.

Further reading

NOTES

Friday 10th September 2010

09.45–10.15
Management of upward fixation of the patella

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Regenerative therapy for equine joint disease - where are we at?

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Regenerative therapies are based in biologics which capture the body’s natural ability to heal. There are several types of regenerative therapies being used including platelet rich plasma (PRP), stem cells of several varieties (only bone marrow concentrate is discussed herein), and autologous conditioned serum (ACS)/interleukin-1 receptor antagonist protein (IRAP). Each of these therapies is relatively new so there is very limited clinical data accumulated to date, and none published on naturally occurring joint disease in equine patients.

Autologous conditioned serum (ACS)
ACS was probably the first biologic to be tested in horses. ACS is generated through the same process as IRAP, but for primarily legal reasons, it is called ACS. It is thought to act by blocking the receptor to the inflammatory cytokine interleukin-1 (IL-1). When injected intra-articularly into horses with surgically created synovitis/early arthritis, ACS resulted in decreased synovial hyperplasia and lameness compared to placebo treated groups (Frisbie et al. 2007). There is a newer generation of ACS termed IRAP II which boosts increased IRAP levels and is presently being tested by the equine group at Colorado State University.

Platelet rich plasma (PRP)
PRP is defined as plasma with a 2 or more fold increase in platelet concentration above baseline levels or >1 x 10^6 platelets/μl (Miller et al. 2007). PRP is generated primarily by centrifugation or gravity filtration. There are differences in the volume of autologous blood required, time and speed of centrifugation, addition of an activating agent, leucocyte concentration, method of delivery and qualitative/quantitative differences with respect to final PRP volume and final platelet and growth factor concentrations between the available systems. Overall, the final PRP platelet concentration is 2–8 times over baseline. It is important to recognise and understand that there are obvious differences between types of platelet concentrates being used and the general term/abbreviation PRP will be used herein.

The concept that PRP would improve joint disease is based on the physiological role of platelets in wound healing. Through a modulation of the inflammatory response, promotion of local angiogenesis, attraction of fibroblasts and local stem cells to the site of injury and an induction of autocrine growth factor production by uninjured adjacent cells, platelets and their products are instrumental in normal tissue repair and regeneration.

Once isolated, the PRP can be injected into a joint with or without an activating (clotting) agent. The addition of bovine thrombin to the PRP sample just prior to or during injection is used in some systems to activate platelets resulting in initiation of the clotting cascade. Clotted PRP serves as a fibrin matrix which serves as a scaffold for tissue repair and a reservoir for retention and slow release of growth factors.

The application of PRP in joints is relatively new and therefore there are limited publications investigating its use. Chondrocytes and MSCs exposed to PRP both have significantly increased cell proliferation and cartilage extracellular matrix synthesis of proteoglycans and collagen type II compared to controls (Akeda et al. 2006; Mishra et al. 2009). Synoviocytes from OA patients cultured in PRP demonstrated significantly increased hyaluronic acid production and secretion, suggesting that PRP could potentially serve as an endogenous source of chondroprotection and joint lubrication following intra-articular application (Anitua et al. 2007). There are several human clinical studies supporting the use of PRP for arthritis, but no horse data is presently available in peer reviewed form. There are several promising abstracts and conference proceedings reporting its use, but again, nothing yet in peer reviewed form.

Bone marrow concentrate (BMC)
Bone marrow concentrate is generated through centrifugation of bone marrow aspirate. The advantage of BMC over PRP is that it contains MSCs which have demonstrated utility for regeneration of cartilage and other tissues of the musculoskeletal system. Like PRP, BMC is a fully autogenous biologic that can be generated patient-side and when clotted, form a scaffold. Also, like PRP, BMC contains platelets and therefore is a rich source of growth factors including PDGF and TGF-B.

In an equine model of 15 mm diameter, full thickness cartilage defects, BMC resulted in significantly improved cartilage repair compared to microfracture using short-term arthroscopic inspection and longer-term macroscopic, histological and quantitative magnetic resonance imaging analyses (Fortier et al. 2010). Differences between BMC and microfracture observed arthroscopically at 12 weeks persisted at 8 month evaluation. In particular, repair tissue in BMC-treated defects was much better integrated into surrounding normal cartilage, the tissue was thicker, and had a smoother surface. Like PRP, BMC is being used as a primary intra-articular joint injection, but no clinical data has been reported on its use.

In summary, regenerative therapies are showing tremendous promise for the treatment of equine joint disease, but the therapies are too new to draw any firm conclusions regarding specific indications, contra-indications, or prognosis following their use.

References and further reading


Introduction

Regenerative medicine offers the prospect of restoring normal, or as close to normal, structure and function to an injured organ and thereby resulting in a successful restoration of activity without the risk of re-injury. Over-strain and traumatic tendon and ligament injuries are common in the horse and, for the most part, heal (repair) naturally by the formation of scar tissue. However, the scar tissue formed in this repair is functionally deficient compared to normal tendon, which has important consequences for the animal in terms of reduced performance and a substantial risk of re-injury, in spite of a multitude of treatments that have been proposed. As pain is not usually a feature of these conditions in the long-term, the primary need is to restore functionality and so this has encouraged the development of regenerative strategies.

Mesenchymal progenitor cells (MPCs) have been considered an ideal source of cells for regenerative medicine because it can be demonstrated, in horses as in other species, that they are capable of differentiating into different cell lines and synthesise new matrix (usually chondrogenesis, adipogenesis and osteogenesis). These cells are thought to be present in small numbers in most tissues but we have chosen to harness the action of MPCs recovered from bone marrow because of ease of recovery, minimal donor site morbidity, and, as these stem cells can be recovered from adult tissue, the possibility of autologous re-implantation which carries fewer regulatory and safety issues. Furthermore, in comparative experiments assessing multipotency, bone marrow-derived MPCs tend to out-perform MPCs from other sources.

Equine digital flexor tendon strain injuries provide many of the elements required for tendon tissue engineering - the lesion manifests within the central core of the tissue thus providing a natural enclosure for implantation and, by the time of stem cell implantation, is filled with granulation tissue which acts in the role of a scaffold. It has the added advantage of being highly vascularised and a natural enclosure for implantation and, by the time of stem cell implantation, is filled with granulation tissue which acts in the role of a scaffold. It has the added advantage of being highly vascularised and therefore capable of nutritional support of the implanted progenitor cells. The cytokine and mechanical environment, which are potentially important drivers for differentiation, is provided by the intra-tendinous location of the cells and the suspension of MPCs in bone marrow supernatant which we have shown to have significant anabolic effects in vitro (Smith et al. 2006).

Post injury, tendon does not exhibit a problem with cellular infiltration but those cells actually involved in the synthesis of new tissue are mostly locally derived cells (Kajikawa et al. 2007). Most tissues have a small population of precursor cells (tissue-specific progenitor cells) that are used to replenish cells due to natural turnover and aid in repair post injury. Evidence of multipotency has been shown for cells derived from young tendon; however, in adult tendon, it has been difficult in our laboratories to demonstrate the presence of a cell sub-population capable of differentiating into multiple cell lines, other than possibly their own, with similar ability to bone marrow derived cells, which may explain why this component of the repair process is limited and hence natural repair inferior to normal tendon.

We have therefore hypothesised that the implantation of autologous MPCs, in far greater numbers than are present normally within tendon tissue, would have the potential of improving the repair of the tendon both structurally (by optimising mechanical properties, organisation and composition) and functionally (by reduced re-injury rates).

Materials and methods

Bone marrow was recovered from the sternum under standing sedation, generally within one month of injury and transferred to a laboratory for culture and expansion of MPCs. After approximately 3 weeks, the cultured cells were transferred back to the veterinarian (10–50 x 10⁶ cells, depending on the extent of the lesion) and implanted into the damaged tendon of the same horse under ultrasound guidance. After implantation, the limb was bandaged and the horses underwent a week of box rest followed by a controlled exercise programme for up to 48 weeks.

Experimental study

Ten horses with naturally occurring SDFT injury were randomly allocated to treatment groups (1 x 10⁷ autologous bone marrow derived MPCs, obtained as described above) were implanted into the damaged SDFT of the treated group. Saline was injected into the control group. Horses received controlled exercise and were subjected to euthanasia after 6 months. Nondestructive mechanical testing assessed structural stiffness of the SDFT and morphological and compositional analysis was performed on the tendon tissue.

Results

Clinical data

To date in excess of 1500 horses have been treated worldwide with this technique. Ultrasonographic appraisal of treated cases show a rapid filling-in of the hypoechoic lesions although a reduced longitudinal striated pattern usually persists. Occasional hypoechoic needle tracts can be identified in some horses for up to 3 months after implantation. Analysis of clinical outcome in 113 treated National Hunt racehorses gave a re-injury rate of 28.9% for those horses which had returned to full training and had been followed up for 2 years after treatment. This re-injury rate was significantly better than for the same type of horse treated conventionally and analysed in the same way (56% re-injury rate for National Hunt horses; P<0.05 [Dyson 2004]). A more limited number of injuries to other tendons and ligaments cases have also been treated so that firm conclusions on efficacy for these injuries can not be made. For lesions present within a tendon sheath, the implantation was performed after tenoscopic evaluation to ensure that there are no surface defects through which the cells could leak.

Histopathological examination has been carried out on 17 tendons from post mortem samples obtained from 12 horses which have undergone MPC implantation. These have shown both good quality healing with minimal inflammatory cells and crimped organised collagen fibres. Furthermore, there was no evidence of any abnormal tissue or neoplastic transformation. In addition, labelled MPCs were detected in enclosed lesions for up to 4 months, similar to that described previously (Guest et al. 2008).
Experimental study
MPC-treated tendons exhibited normalisation of their mechanical, morphological and compositional parameters towards that of uninjured tendons. This was significantly different (P<0.05) from saline treated tendons for cross-sectional area, cellularity, crimp pattern and DNA content.

Conclusions
Treatment with MPCs appears to reduce re-injury rates in superficial digital flexor tendon injuries in National Hunt racehorses. This is supported by improvement in mechanical, morphological and compositional parameters in a controlled experimental study using natural disease.

Acknowledgements
This work was performed in collaboration with VetCell Bioscience Ltd of which R.K.W.S. is a Director.

References
Development of cell based strategies in the management of orthopaedic conditions - needs in man and animals

The musculoskeletal system is susceptible to both high morbidity disease and degenerative conditions as a consequence of both injury and age and exercise-related factors. The component structures exhibit a wide range of regenerative capacity, from bone where damage is resolved without scarring to cartilage where repair let alone regeneration is difficult to achieve. The range of conditions is seen in both man and other animal species, thus both induced and natural models in animals can provide insights for the management of human disease.

Mammalian species show limited capacity for true regeneration; however, bone repair tissue has been shown to express genes only seen in bone formation in embryonic development, confirming that bone can recapitulate embryonic development, as is also the case in antler growth of deer. The tissue differentiation in the process of bone repair reflects the mechano-sensitivity of the developing tissues and thus provides exciting potential for in vivo tissue regeneration, utilising the endogenous sources of progenitor cells. Such strategies already show potential for the biological replacement of damaged and degenerate skeletal structures.

Injury and tissue damage induce inflammation, which initiates repair. This often results in a change in both material and structural properties of the injured components of the musculoskeletal system leading to a longer term degeneration, as is seen in conditions such as secondary osteoarthritis. The strategy behind cell therapy and tissue engineering is to regenerate tissue and structures with normal functional competence. The application of exogenous multi-potent cells is used in a number of approaches to enhance tissue regeneration in skeletal tissues by direct application in conditions such as delayed or nonunion fractures and in tendon degeneration. Such strategies can also be used where treatment compromises the endogenous cells, for example reconstruction of structures following resection preceded by the use of cytotoxic agents.

The integration of implants used to replace components of the skeletal system can also be enhanced by the incorporation of multi-potent cells at the implant tissue interface. A near biological replication of tendon insertions is induced with adjunct cell therapy and rapid osseo-integration of joint replacement components is also achieved using this approach. Translational outcomes from both induced and spontaneous in vivo models are already showing potential for clinical application in human conditions.
16.15–16.40

Proximal metacarpal lameness - what has MRI taught us?

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No abstract submitted

NOTES
The challenge of the successful management of proximal suspensory desmitis in hindlimbs

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Proximal suspensory desmitis (PSD) is a common condition in horses from all types of disciplines, with dressage horses being particularly at risk (Murray et al. 2006). Successful management is dependent on accurate diagnosis (Dyson 1994, 1995a,b, 2007). Clinical manifestations vary widely from an overt unilateral hindlimb lameness to a subtle performance problem, such as inability to perform right canter pirouette, generalised stiffness, or behavioural changes such as bolting or resisting. Proximal suspensory desmopathy might be a more appropriate term in some horses in view of the histological characteristics of injured ligaments and the absence of signs of inflammation in the majority (Dyson 1995b, 2007). There is growing evidence that at least in some horses this is a degenerative condition on which work trauma may be superimposed (Mero and Pool 2002; Halper et al. 2006; Schenkman et al. 2009). Pain causing lameness may originate from the ligament itself or be associated with compression of the adjacent nerves (Dyson 2007; Toth et al. 2008). The suspensory ligament (SL) is effectively within a compartment bounded by the plantar aspect of the third metatarsal bone (MttIII), the second and fourth metatarsal bones (MttII and MttIV) and the deep fascia running between the plantar aspects of MttII and MttIV.

How sure are we of the diagnosis? How accurate is diagnostic ultrasonography? The degree of response to perineural analgesia of the deep branch of the lateral plantar nerve

Although in some horses diagnosis is straightforward, it is clear that a positive response to perineural analgesia of the deep branch of the lateral plantar nerve does not necessarily imply PSD. Moreover false positive and false negative results of diagnostic ultrasonography can be obtained (Labens et al. 2010). The proximal aspect of the SL in hindlimbs can be difficult to examine ultrasonographically because of the shape of the limb limiting the ‘window’ through which the SL can be examined and artefacts created by adjacent blood vessels. It is crucial to critically evaluate the degree of response to perineural analgesia of the deep branch of the plantar lateral nerve and if the lameness is improved <90% consider infiltration of local anaesthetic solution toward the entheses, addition of intraarticular analgesia of the tarsometatarsal joint, addition of a Tibial nerve block or Tibial and fibular nerve block, or infiltration of local anaesthetic solution around the saccrociac joint regions.

Confounding issues

Other sources of pain may be contributing to pain and either lameness or poor performance. The accessory ligament of the SL attaches to the plantar aspect of the fourth tarsal bones and the calcaneus resulting in a close anatomical and functional relationship between the SL and the tarsus. Distal hock joint pain may coexist with PSD. Saccrociac joint region pain occurs quite commonly in association with bilateral PSD. In association with PSD there may be increased radiopharmaceutical uptake in the proximoplantar aspect of the MttII reflecting reaction at the enthesis. Enthesese new bone formation at the origin of the SL on the plantar aspect of the MttII may contribute to continued irritation of the SL. Recognition of conformational abnormalities which are either a predisposing factor for injury or reflect loss of function of the suspensory apparatus is important, because these are poor prognostic indicators.

Treatment options

Treatment options include extracorporeal shockwave therapy, radial pressure wave therapy, rest and local infiltration with a variety of products including corticosteroids, homeopathic drugs, porcine bladder matrix (A Cell), injection of platelet rich plasma or mesenchymal stem cells, desmoplasty, fasciotomy and neurectomy of either the deep branch of the lateral plantar nerve or the tibial nerve and osteostixis (Crowe et al. 2004; Bathe 2006; Heves and White 2006; Launois et al. 2006; Kelly 2007; Pauwels et al. 2009).

References


Diagnosis and management of suspensory ligament branch injuries

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To date, textbooks and the majority of scientific presentations have dealt with injuries of the branches of insertion of the suspensory ligaments as single entities. However, their varying location and morphology suggests that this may be an inaccurate simplification.

The anatomy of the suspensory apparatus is such that the relationship of the branches to the proximal sesamoid bones and the second, third and fourth metacarpal/metatarsal bones creates both primary and secondary lesions. The entire unit of the suspensory ligament and its associated structures therefore need careful assessment.

Diagnosis is formulated following:

**Clinical appraisal**
Assessment of conformation and posture, lameness evaluation and palpation.

**Radiographic examination**
Four standard views of the metacarpophalangeal/metatarsophalangeal joints plus proximodistal oblique projections (medial and lateral) of the proximal sesamoid bones are standard requirements. When clinical examination reveals thickening of the proximal half of a suspensory ligament branch then radiographic examination of the second/fourth metacarpal/metatarsal bone(s) also is indicated.

**Ultrasonographic evaluation**
Imaging requires a linear probe (~10 MHz) and standoff pad. Transverse, longitudinal and varying oblique images with the limb weight bearing should be obtained for complete assessment.

Lesions of the suspensory ligament branches can be divided into several categories:

**Dorsal (articular) lesions**
Palpable changes of the suspensory ligament branch (SLB) are variable but distension of the palmar/plantar pouch of the metacarpophalangeal/metatarsophalangeal joint is common. Careful ultrasonographic evaluation will usually image disruption of the dorsal (articular) margin. This is most commonly seen as an irregular hypoechoic/anechoic zone sometimes with evidence of dorsal (articular) extrusion of disrupted tissue. The dorsal surface may also be convex/protruberant. Management necessitates arthroscopic evaluation and removal of the disrupted tissue.

**Central (core) lesions**
Palpable thickening in the SLB is usually identified and digital pressure resented. Ultrasonographic evaluation identifies the extent of the lesion. These are closed space lesions. Management strategies include regenerative therapies (i.e. bone marrow derived mesenchymal stem cells or platelet rich plasma), percutaneous needle fenestration (decompression) and symptomatic anti-inflammatory therapy.

**Axial lesions**
Palpation frequently identifies thickening of the SLB which is greatest on the palmar/plantar margin and may be accompanied by a variable amount of periligamentous soft tissue thickening. Disruption of the branch is identified ultrasonographically which usually reveals also extrusion of disrupted fibrils through a breach in the epidesmon. Conservative treatment is frequently disappointing. Surgical removal of the disrupted tissue appears to improve the prognosis.

**Diffuse desmitis**
A generalised increase in size of the SLB(s) is palpable and there may be involvement of the entirety of the suspensory ligament or specifically the branch(es). Ultrasonography can confirm palpable changes and also rule out other types of branch injury. An increased cross-sectional area along with a generalised reduction in echogenicity without ultrasonographic evidence of localised disrupted infrastructure is usually imaged. The amount of periligamentous soft tissue thickening is variable. Case management is determined largely by aetiology.

**Avulsion injuries**
Focal avulsions of the suspensory ligament branch from the abaxial margin of the proximal sesamoid bone may be primary ligament or osseous failure or a combination of these. They are most frequently either unilateral and uniaxial or uniaxial and bilateral. In some horses pre-existing proximal sesamoid bone changes can be imaged radiographically and it is thought these represent primary osseous compromise. Osseous avulsions can range from small fragments to substantial abaxial fractures. In all cases conservative management has been associated with a poor prognosis for a return to athletic use. Removal of disrupted tissue followed by second intention healing can improve this in some horses.

**Combination injuries**
These can present with several types of injury usually superimposed on a chronic degenerative process. Management is determined on a case by case basis.

Further reading
Proceedings of the 49th British Equine Veterinary Association Congress
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Examining the stallion for breeding soundness - what a five stage vetting doesn’t tell you

Paul R. Loomis and Sandro Barbacini

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Seminal Collection Techniques

Seminal samples can be obtained from intact stallions by manual stimulation, chemical ejaculation, condom or artificial vagina. For decades stallion semen has been collected using artificial vaginas (AVs) for the purpose of evaluating semen production and quality and for procurement of sperm for artificial insemination or preservation. A variety of models of AVs have been developed and many will work well to reliably obtain semen samples provided they meet certain basic requirements. These requirements include; the ability to provide sufficient stimulation to the stallion’s penis through pressure and elevated temperature (typically 45–50°C), the ability to adjust size and temperature for requirements of individual stallions, a non-spermicidal receptacle to recover the ejaculated semen and prevent sperm from changes in temperature and the ability to be positioned or held in place alongside an oestrous jump mare or phantom. The inner liners used for the AV must be lubricated, non-spermicidal and soft enough to promote ejaculation. The AVs most commonly used in the United States are the Colorado model and the Missouri model. In both of these models, elevated internal pressure and temperature is achieved by filling the space between 2 rubber or latex liners with warm water. Many AVs have liners or collection receptacles that include an in-line filter to prevent the mixing of sperm rich fractions of the ejaculate with the gel-fraction (contributed by the seminal vesicles) and any debris that may be introduced during collection. Nylon mesh filters are preferred over cotton or polyester ‘milk-line’ filters as they do not absorb significant numbers of spermatozoa when the semen is filtered as is the case with the milk-line filters.

In some European countries, open-ended AV’s are commonly used to collect stallions. This technique allows the collection of ‘fractionated ejaculates’ or only the first few (sperm-rich) fractions of the ejaculate leaving behind or collecting separately the fractions of the ejaculate that contain few sperm and primarily secretions from the accessory sex glands.

Regardless of the AV used it is imperative that during the collection process the fragile spermatozoa are not damaged. Stallion sperm are extremely susceptible to damage from changes in temperature and osmolality and from exposure to spermicidal substances such as soap residues on collection equipment. One criticism of the older Colorado model AVs was that because they were so long (21 inches [53.34 cm]) that a stallion with a short penis was ejaculating in the interior of the AV possibly trapping the sperm in the AV where they could be exposed to elevated temperatures of >45°C if the collector was not careful to quickly release the internal pressure. The introduction of shorter Colorado model AV’s (15 and 19 inches [38.1 and 48.26 cm]) eliminates this concern as the stallion’s penis now can penetrate all the way through the body of the AV allowing for the sperm to be ejaculated into the inner AV liner in an area that protrudes out the back and is not exposed to elevated temperatures. Similarly, cold environmental temperatures can easily ‘cold shock’ sperm that are collected into a receptacle that is not protected by an insulated cone or cover of some type. An insulated cone that is warmed in an incubator and placed around the back of the AV to protect the collection bottle will protect the sperm.

The interior of any AV must be lubricated to allow the stallion to thrust without causing irritation or friction. Lubricants that are commonly used are water soluble to allow for easy cleaning of the liners. If excessive amounts of water soluble lubricants are used then it is possible that some of that lubricant will be pushed down into the collection bottle and dissolve in the ejaculated semen. Most of these lubricants have a very high osmolality and will result in osmotic damage to the sperm from the resulting increased osmolality of the semen lubricant mixture. In the last few years there have been brands of water soluble lubricants introduced to the market that have an osmolality similar to semen and therefore will not cause damage to the sperm if inadvertently mixed with semen during collection. Some ‘sterile’ lubricants also contain chlorhexidine to prevent growth of unwanted organisms. Chlorhexidine is highly spermicidal and exposure of sperm to chlorhexidine containing lubricants will also cause damage.

Another potential concern is that spermicidal residues from soap, disinfectants or tap water on collection equipment (liners, bottles, phantom, etc.) will result in sperm damage. New disposable liners can be used to eliminate the need for cleaning of latex or rubber AV liners to prevent this problem provided the stallion accepts the liners. Many stallions do not like the feel of a plastic AV liner because of the inevitable wrinkles that can cause discomfort and may require the use of a latex liner. If reusable latex liners are used they must be disinfected, washed and thoroughly rinsed. I have attached a copy of the ‘Select Breeders Service Standard Operating Procedure for Semen Collection and Disinfecting the Phantom and Collection Equipment’ to illustrate the protocol currently in place in SBS laboratories. When collecting semen using an AV, the stallion is encouraged to mount a properly restrained oestrous mare (jump mare) or can be trained to mount a stationary breeding mount (also known as a phantom or dummy mount). Ovariectomised mares can be reliably used as jump mares and usually require exogenous oestrogen (oestradiol cypionate -ECP 2–5 mg) to encourage oestrous behaviour. Stationary breeding mounts should be constructed of materials to provide a secure, solid foundation with limited movement while the stallion is mounted. The body should be of an appropriate diameter and be well...
padded to prevent injury to the stallion. Ideally, the height and angle of the horizontal ‘body’ of the mount should be adjustable if stallions of various sizes are to be collected. Breeding mounts should be positioned in a large open area to provide adequate space around the phantom. Ceiling height in the breeding shed must also be sufficient to allow the stallion to mount and dismount the phantom without risk of injury. The material used to cover the phantom must be made of a durable material that can be readily disinfected to minimise cross contamination of potentially pathogenic organisms that may be present on the external genitalia or in pre-ejaculatory secretions between stallions. Recently, phantom covers or drapes with built-in ‘hips’ have become available and are useful to provide additional stability for the stallion.

Nearly all stallions can be readily trained to mount a phantom for semen collection with an AV. Care should be taken when training young inexperienced stallions to mount a phantom as improper techniques that lead to negative experiences for young stallions can lead to long-term negative behaviours in the breeding shed. An experienced team including a competent, quiet yet firm and patient stallion handler as well as an experienced collector and capable mare handler are needed to ensure that these early breeding experiences are positive for the young stallion.

Once the stallion has mounted the phantom or jump mare, the collector should carefully deflect (not firmly grasp) the stallion’s penis and direct it into the AV. When collecting semen for cooled or frozen preservation it is desirable to obtain an ejaculate that is low in volume and high in sperm concentration. Seminal plasma is not a good extender for stallion sperm and preservation protocols, both cooled and frozen require adequate dilution or removal of much of the seminal plasma for optimal retention of sperm motility. Most stallions will emit some sperm-free pre-ejaculatory fluid when they mount. We will routinely attempt to void as much of this pre-ejaculatory fluid as possible by holding the stallion’s penis out of the AV for a few seconds while the fluid is expelled. Some stallions may void as much as 40 or 50 ml of this fluid. An ejaculate that contains semen with a sperm concentration of 90 million per ml in 100 ml of volume may have enough that volume reduced by voiding pre-ejaculate fluid resulting in the same 9 billion sperm in 70 ml at a concentration of 128 million per ml. As discussed in a later presentation on cooled semen processing, we would routinely concentrate sperm by centrifugation prior to cooling for an ejaculate with a sperm concentration <100 million per ml whereas the semen containing 128 million sperm per ml could be sufficiently diluted for cooling without centrifugation. This technique does not work for all stallions as some will not emit any pre-ejaculatory fluid outside of the AV and others may protest being held out of the AV and dismount. Every effort should be made to obtain an ejaculate on a single mount without excessive prior teasing which leads to increased accessory sex gland production, greater amounts of seminal plasma and lower concentration of sperm in the ejaculated semen. Numerous factors can affect sperm production in the stallion and those are addressed by another speaker at this conference so will not be addressed here. It is important to reiterate, however, that poor collection technique and improper semen handling can definitely have a negative impact on the quantity and quality of the ejaculate obtained when collecting semen with an artificial vagina.

Many stallions can be trained to have semen collected with an AV while standing on all 4 legs (ground collecting) or without an AV by manual stimulation. These techniques are useful for stallions with hindlimb injuries that cannot physically mount a mare or phantom. Ground collecting has also been advocated for some situations where personnel or collection facilities are limited.

In certain circumstances, when a stallion cannot mount a mare for collection or will not respond to ground collecting techniques with AV or by manual stimulation, ejaculation may be induced by use of pharmacological agents such as xylazine and imipramine. One recommended protocol is to administer 2.0 mg/kg bw t.i.d. imipramine hydrochloride i.v. If this does not induce erection and ejaculation within 10–15 min, xylazine is administered i.v. at a dose of 0.2–0.3 mg/kg bw t.i.d. In this scenario ejaculation usually occurs with erection and masturbation. Xylazine used alone can also induce spontaneous ejaculation without erection as the stallion enters a state of sedation. Some stallions will respond well to this treatment and in those cases, high density, low volume ejaculates of good quality semen can be obtained. However, the effective dose required to illicit a response seems to vary between individuals and many stallions either will not respond at all or will respond very inconsistently. In these cases chemically induced ejaculation is not a reliable means to consistently obtain semen for routine use.

**Semen evaluation**

Whether semen is collected for the purpose of evaluating fertility potential, diagnosing subfertility, use for artificial insemination in mares or for long-term preservation, a basic evaluation of semen quality should be performed. A proper evaluation of semen starts by first doing no harm. The results of your semen evaluation no matter how elementary or sophisticated are invalid if the sperm obtained are damaged during the collection process or mishandled during evaluation. Sperm are fragile and extreme care must be taken to avoid thermal shock, osmotic shock, exposure to direct sunlight or exposure to substances that are spermicidal. All equipment that comes into contact with the sperm must be warmed, clean and free of residues. Whenever possible, new disposable specimen cups, pipettes and AV liners should be used. The basic goals of semen evaluation are to measure the quantity and quality of sperm in the ejaculate and also to identify potential pathogens that may be present.

**Gross appearance**

Raw semen should be evaluated for colour. Red or brown semen may indicate blood in semen (haemospermia) or genital tract infection. Yellowish semen may indicate urine in the semen (urospermia). Urospermia can be confirmed by the presence of a urine smell to the semen and microscopically by the presence of urine crystals in the semen. Clumps, mucous or excessive debris in the semen may indicate a genital tract infection or a cleared occlusion of sperm sometimes occurring in the ampullae of sexually rested stallions.

**Volume**

In order to determine the total sperm produced in the ejaculate an accurate measurement of sperm volume should be made using a graduated cylinder or centrifuge tube. The gel-fraction of the ejaculate should be removed using an in-line filter during collection and should not be included in the recording of ‘gel-free volume’. Weighing raw stallion sperm using an accurate balance is also an effective way of determining semen volume. We recently performed an experiment in our laboratory to comparing the weight of raw stallion semen with the volumes as measured by reading the volume in a graduated centrifuge tube and found that our visual measurements correlated very well ($r^2 = 0.99$) with volumes measured by weight.

**Concentration**

The concentration of sperm in semen can be measured by both manual and automated techniques. One very important criterion...
for the accurate measurement of sperm concentration is accurate mixing, pipetting and dilution of raw semen. Proper pipetting technique and use of properly calibrated pipettes is critical as a very small error made in measuring raw semen will be magnified when the sample is diluted for counting and that error is multiplied as the concentration of the original sample is calculated. Regardless of the counting technique used, extreme care must be exercised when pipetting raw semen and making dilutions.

Haemacytometer
The haemacytometer has long been considered the 'gold standard' for accurate cell counting. Loading a sample onto a grid of known depth and manually counting the number of sperm within the grid is the basic principle behind haemacytometry and most automated methods for determining sperm concentration are based on calibration against this ‘gold standard’. There are, however, numerous limitations to haemacytometry that must be considered. Manual sperm counting is time consuming and relies on the human technician to determine sperm from non-sperm in a sample and where exactly on a grid line a sperm should be included or excluded from the count. The variation introduced due to differences in such human judgement requires that adequate replicates of a given sample be measured to provide a reliable measurement. Nevertheless, if done properly using an adequate number of replicates and a standardised and consistent protocol for dilution, chamber loading and cell counting, haemacytometry can be an excellent way to determine sperm concentration. I have attached the SBS Standard Operating Procedure for counting sperm with a haemacytometer for reference. Our research indicates that one must count a minimum of 4 individual chambers from each sample to provide a measurement with an acceptable level of variation.

Photometric technique (Densimeter, SpermaCue, etc.)
There are numerous photometric-based counting devices commercially available for the automated estimation of sperm concentration. All of these devices are based on the following principle. A light source is passed through a sample chamber and the amount of light transmitted through the sample is detected by a photocell positioned on the other side. If the light is passed through a chamber that is empty or contains only optically clear diluent, 100% of the light will be detected by the photocell. When a known volume of semen is added to the chamber (raw semen for the SpermaCue and diluted semen for the other photometers) some of the transmitted light is blocked by the now opaque sample in the chamber. The amount of light that is blocked is correlated with the concentration of sperm in the semen sample. Since this technique does not involve actually counting individual cells, the sperm concentration is inferred from the light absorption. All photometers must be calibrated so that light absorption can be correlated to sperm concentration. Traditionally, such calibrations are done by haemacytometry of samples at different concentrations to develop a standard curve. Obviously, any errors in the accuracy of the haemacytometer measurements used to develop the standard curve will also be present in the photometer measurements. Anything in a sample of semen that blocks the transmission of light will be interpreted as sperm in a photometer and therefore the presence of debris, other cells, urine crystals or extender components will result in an overestimation of sperm concentration. In most cases, however, a well calibrated photometer is a reliable means to provide a rapid and reasonably accurate estimation of sperm concentration and is suitable for use in most breeding applications.

Automated Cell Counting Techniques (NucleoCounter SP100, CASA)
The NucleoCounter SP100 is a fairly new piece of equipment that uses direct counting of fluorescently labelled sperm heads to accurately and rapidly determine sperm concentration. A known volume of semen is diluted with a solution containing a detergent that causes sperm membranes to be permeable to a specific DNA intercalating stain. The stain binds to the DNA and when illuminated with UV light, emits fluorescence in a specific wavelength of light. That fluorescent image (sperm heads only visible) is then digitised and software is used to count the sperm in a fixed given area. From that count the sperm concentration is calculated. Using this technique, sperm suspended in extenders, even those with a high percentage of non-clariﬁed egg yolks can be accurately counted. The system uses a unique cassette preloaded with the fluorescent stain propidium iodide (PI) into which the diluted and membrane permeabilised sperm are loaded by depressing a plunger. The sperm then travel through a series of channels, are exposed to the PI and then dispersed into a viewing field for illumination and identiﬁcation. We have validated this system with haemacytometry in our lab and found it to be accurate and highly repeatable.

Computer Assisted Semen Analysis (CASA) was developed in the 1980s as a way to use image analysis to objectively and accurately quantify the measurement of sperm motility (see below). It has also been used as a system for automatic cell counting. In this system, microscopic images of live sperm are captured by video camera, digitised, identified and tracked through successive video frames. Computer software is then used to trace the position of the sperm heads from one frame to the next and recreate the path of the sperm. By using a chamber with a known depth, the area of the field being viewed is calculated and the concentration of sperm in the sample can be determined based on the number of cells identiﬁed within that area. The principle is the same as haemacytometry but in this case the counting is being done by computer. There are advantages and disadvantages to this. CASA allows for many more cells to be counted in a shorter period of time and any bias or subjectivity introduced by a human is eliminated as the software uses defined algorithms to determine what will be counted. However, there are signiﬁcant disadvantages. First is the accurate determination of sperm from non-sperm debris in the sample. CASA uses the size and intensity of any object in the field to determine if it should be counted as a sperm or not. The algorithm ﬁrst identiﬁes all objects that have a size above a certain user deﬁned minimum. If that object is moving it is considered a sperm. The average size and intensity of all the moving objects is then calculated and then compared to the size and intensity of all the nonmoving objects (nonmotile sperm and other objects). If the size and intensity of a nonmoving object falls within user deﬁned ‘gates’ for size and intensity of the mean of the moving objects, then that nonmoving object is labelled and counted as a sperm. The number of moving objects and labelled nonmoving objects is combined and that cell count is used to calculate the sperm concentration. Issues associated with mislabelled objects and with inaccurate tracking of motile sperm due to ‘virtual collisions’ can lead to inaccurate measurements of sperm concentration using this system.

Another source of error is associated with the dynamics of particle ﬂow within the fixed coverslip counting slides (Microcell, Leja slide) typically used for CASA. For any direct counting method the area that the counted sperm occupy must be known in order to calculate concentration. A typical slide with a ﬂoating coverslip does not provide a consistent depth under the coverslip and so these slides have been developed. There is a phenomenon of particle ﬂow (known as the SS effect) that causes an uneven
distribution of cells in a semen sample across the chamber of these fixed coverslip slides and this can lead to errors in sperm concentration measurements unless a correction factor is applied. We have developed a protocol in our laboratory that eliminates some of these sources of error and allows for accurate and rapid counting of sperm using a CASA system and fixed coverslip slides. To eliminate the effect of ‘collisions’ we dilute the samples with formalin or sodium citrate to immobilise the sperm and then count only static cells in the sample. We have also calculated a correction factor that we apply to the concentration to account for the SS effect for stallion sperm in this system. We validated this method using the NucleoCounter SP100 described below and use it to increase the number of cells counted and decrease the time associated with direct manual counting associated with the haemacytometer. One can also use DNA specific fluorescent stains and special software on some CASA models to eliminate errors due to misidentification of objects within a sample and allow the tracking and counting of sperm diluted in nonclear extenders.

**Motility**

Once we have a good measurement of the quantity of sperm in the semen it is necessary to determine what percentage of those sperm may potentially be able to fertilise an oocyte when inseminated into a mare. While fertilisation is a very complex process that requires the sperm to possess a number of functional attributes many of these attributes are unknown or cannot be readily measured using standard laboratory techniques. Sperm motility is the most widely used and readily assayed measure of sperm function and for decades has been used as an indicator of the potential of a semen sample to achieve pregnancy in the mare. Early work on determining the quantity of sperm required for optimal fertility in an artificial insemination programme relied on a subjective estimate of ‘progressive motility’. Sperm motility can be measured either subjectively by a technician visually observing a sample of semen under a microscope or by computer assisted semen analysis (CASA). Sperm are very sensitive to fluctuations in temperature and this is readily apparent when observing sperm motility. The velocity and ‘progressivity’ of sperm are significantly decreased when sperm are observed at temperatures that vary significantly from 37°C. After collection, the semen should be kept in a 37°C environment and all items coming into contact with the semen including microscope slides, coverslips and extenders should be prewarmed to 37°C. Use of a heated microscope stage or slide warmer is highly recommended. In order to properly visualise the motility of individual sperm and, therefore, determine progressive motility, raw semen should be diluted with an appropriate pre-warmed extender at a concentration of 25–40 million sperm per ml. After dilution the semen should be kept at 37°C for 5 min to equilibrate prior to reading motility. If the motility of the extended semen is very poor or the sperm look ‘shocked’ or appear to be dying quickly on the slide, examine a drop of the undiluted raw semen to see if the poor motility may be due to something wrong with the extender. If the extender is not at the right temperature (either too hot or too cold) or if it is not in the proper cosmetic range it could kill the sperm very quickly.

An experienced technician can generally obtain consistent and reliable estimates of the percentage of total and progressively motile sperm in a semen sample and this can be sufficient for most breeding programmes. However, because of the subjective nature of motility estimation and lack of a standardised and quantifiable way to estimate motility, there can be great variations between technicians and laboratories as to how they assess the motility of a given sample of semen. There is also a real possibility of inadvertent technician bias introduced during the process that can influence results. In addition, variation in the procedures used for dilution, incubation and motility evaluation of cooled transported or frozen-thawed semen can lead to disputes between stallion and mare owners over the perceived quality of semen received in fulfillment of a breeding contract.

Computer assisted motility analysis using CASA instruments has many advantages over subjective motility estimations. Use of this objective system eliminates much of the inter-laboratory and individual technician variability and bias inherent in subjective estimates. CASA also provides detailed quantitative information on other aspects of sperm motion such as velocity, linearity, lateral head displacement, etc. that are impossible to quantify using subjective estimates. It is also valuable in detecting slight changes in motility when evaluating processing protocols, extenders or tracking a stallion’s overall semen quality during the season or from year to year during his breeding career. I described above briefly how CASA systems identify sperm. For the purpose of evaluating motion characteristics, the labelled sperm heads are tracked during successive video frames and then the trajectory of that path is recreated. From this recreated path, a number of calculations are made. There are calculations of velocity (VCL, VAP) that reflect the distance travelled along the path over unit time, measurements of trajectory such as linearity (LIN) and straightness (STR) which reflect the ratio of distances along the path to the distance from a straight line (VSL) from first frame to last and also measurements of how far and how rapid the sperm head moves from side to side along the path (amplitude of lateral head displacement (ALH) and beat cross frequency (BCF). Figure 1 illustrates how some of these calculations are made.

While use of CASA does provide accurate, objective and repeatable measures of sperm motility it is important to recognise that there are numerous technical factors that can influence the measured values. Standardisation of sample preparation and analysis algorithms is required for reliable comparison of values obtained between operating technicians and laboratories. Furthermore, motility, regardless of how sophisticated its measurement, is only one indicator of relative cell health and the true fertility of any semen sample can only be accurately determined by properly timed insemination of an adequate number of reproductively healthy mares.

**Sperm morphology**

Sperm morphology is a critical but often poorly measured or completely ignored aspect of semen evaluation. All semen samples have a mixture of viable and nonviable spermatozoa and an assessment of the percentage of sperm with ‘normal’ gross morphology as well as categorisation of the quantity of various...
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of these microorganisms are not pathogens in the mare and will not cause disease. There are a number of potential pathogens, however, that can be found in semen and can have a negative impact on fertility as well as spread disease through natural mating or artificial insemination. With the advent of transported semen it is increasingly important to insure that shipped semen does not act as a vector for the spread of disease around the country. Many bacteria and viruses can also survive cryopreservation and live in frozen-thawed semen and could contribute to spread of disease between countries if precautions are not taken.

Bacteria that are potential pathogens in the horse include klebsiella pneumonia, pseudomonas aeruginosa, Taylorella equigenitalis (causative agent of Contageous Equine Metritis) and possibly streptococcus zooepidemicus and Escherichia coli. Swabs should be obtained from the semen, urethra, glans fossa and penile sheath prior to the start of the season and periodically throughout the season to monitor for the presence of these potential pathogens.

Stallions should also be screened for the presence of certain viruses that may be shed in semen. Of these, equine arteritis virus (causative agent of EVA) and equine herpesvirus type 3 - EHV3 (causative agent of equine coital exanthema) are of greatest concern. In cases of haemospermia, blood-borne viruses (such as equine infectious anaemia virus) may also be present in semen. 

Microbiology

Semen from stallions will often contain microorganisms. Semen is not sterile and normal bacterial flora inhabits the external genitalia and will usually contaminate collection equipment resulting in the presence of these organisms in the semen. Many of these microorganisms are not pathogens in the mare and will not cause disease. There are a number of potential pathogens, however, that can be found in semen and can have a negative impact on fertility as well as spread disease through natural mating or artificial insemination. With the advent of transported semen it is increasingly important to insure that shipped semen does not act as a vector for the spread of disease around the country. Many bacteria and viruses can also survive cryopreservation and live in frozen-thawed semen and could contribute to spread of disease between countries if precautions are not taken.

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sperm defects should be performed on all stallions at the beginning of each breeding season and periodically throughout the season especially if there is suspicion of testicular insult or injury that may have impaired spermatogenesis. Good clinical evaluation of sperm morphology requires adequate resolution of highly magnified images of sperm that are stained and fixed as a dry mount or fixed and prepared as a wet mount. A good quality phase contrast microscope fitted with a 100x oil immersion objective is recommended. Preparations commonly used for staining stallion sperm for dry mounts include eosin nigrosin and toluidine blue. Wet mounts can also be prepared on sperm fixed by dilution in 10% formalin or 6% glutaraldehyde. Evaluation of 200 total cells (100 from each of 2 prepared slides) is recommended. In addition to determination of the percentage of normal sperm, sperm with defects should be recorded and categorised. If an individual sperm possesses more than one defect, both defects should be recorded. Therefore, the combined percentages of sperm morphological categories will usually exceed 100%.
Scrotal pathologies in horses are detected relatively rarely since the majority of stallions are castrated at an early age. Only selected individuals remain intact and are used for breeding purposes. Since only a limited number of carefully selected stallions are allowed to breed with mares, acquired pathologies of the scrotum of these valuable animals, as a result of a breeding injury or progressive disease process, can have devastating consequences.

**Acute scrotum**

Acute scrotal conditions in stallions are associated with sudden painful swelling of the scrotum or its contents. This condition may be associated with only local symptoms but may also have generalised signs. The differential diagnosis of an acute scrotum includes trauma, torsion of spermatic cord, inguinal hernia, epididymitis, epididymo-orchitis and large tumours.

**Trauma**

Scrotal trauma is associated with a breeding or teasing accident, jumping through a high fence, or, rarely, through human abuse. Severe trauma may cause orchitis, periorchitis, haematoma, testicular rupture, scrotal lacerations, infection or an abscess, etc. A combination of greyscale and colour Doppler ultrasonography are most helpful in assessing the extent of damage. Disruption of the tunica albuginea, rupture of a proper ligament or haematocele may be identified. Mild trauma with a slight swelling and pain requires implementation of an aggressive medical treatment with NSAIDs, antibiotics and hydrotherapy. However, a testicular rupture, large abscess or extensive haematoma will have to be surgically addressed.

**Torsion of spermatic cord**

Torsion of the spermatic cord in a stallion occurs relatively rarely, but young individuals with a long gubernaculum (proper ligament, caudal ligament of epididymis) are especially prone to develop this condition. Greater than 180° torsion of the spermatic cord causes vascular occlusion, which leads to a serious testicular ischaemia, resulting in scrotal pain and significant swelling. Ultrasound examination reveals decreased echogenicity of the affected testis due to congestion and oedema. A spermatic cord congested above a twisted area, may have signs of thrombosis, and a torsion site is highly echogenic. Blood flow is significantly affected in the distal part of the affected spermatic cord as well as in testicular parenchyma. Treatment is by surgery.

**Hernia**

Scrotal hernia may be congenital or acquired and is usually associated with a delayed testicular descent and large inguinal rings. If a herniating loop of intestine is compromised a serious, painful condition quickly develops. Vascular supply to the testis on the affected side may be also significantly compromised. The scrotal sac is swollen and painful and prevents identification of scrotal structures using manual palpation. Rectal palpation may reveal a large inguinal ring with a loop of intestine entering the vaginal canal. Ultrasound evaluation is very helpful in visualising distended intestines in a scrotal sac. Surgical repair is always necessary, usually in combination with hemi or total castration.

**Nonacute scrotal pathologies**

There are various scrotal pathologies in stallions which do not have an acute onset and, therefore, may be difficult to identify early in the process. These lesions are localised within a scrotum and are not associated with any systemic effects.

**Testicular neoplasia**

The most common testicular neoplasia of a stallion testis is seminoma. These tumours arise from germ cells, may expand quickly and destroy the entire testicular parenchyma. Seminomas are usually focal and have a characteristic appearance on ultrasound (heterogenous echogenicity).

Other testicular neoplastic changes found rarely in stallions are teratoma, Leydig cell tumour, Sertoli cell tumour, embryonal carcinoma and teratocarcinoma. Testicular biopsy is the method of choice for diagnosing testicular tumours. Treatment is by surgery.

**Testicular degeneration**

Testicular degeneration is a significant cause of infertility in a stallion. This condition is most often seen in ageing stallions, but can also be seen in relatively young animals, which are just entering their reproductive career. Affected stallions have a progressive decline in sperm numbers and quality, testicular size gradually decreases and texture of the testes or testis change to flaccid. Concentrations of FSH and LH are elevated and plasma oestradiol decreases in severe cases. Testicular biopsy has the highest diagnostic value in this condition.

To date, there is no protocol for the effective treatment of testicular degeneration in stallions.

**Hydrocele**

A hydrocele is associated with an abnormal accumulation of fluid in the vaginal cavity. A large amount of fluid in the vaginal cavity may affect thermoregulation and spermatogenesis. Unilateral castration is necessary only if a significant discomfort is present or enlargement of the scrotum is severe enough to affect the contralateral testis.

**Varicocele**

Congenital dilatation of the veins in the spermatic cord are seen relatively often in normal and subfertile stallions. Severe varicoceles in stallions may be detectable by manual palpation and is described as ‘bag of worms’. However, enlarged veins in the pampiniform plexus are much more often visualised using ultrasonography.

To date, there is no other treatment of varicocele in stallions than castration.

**Conclusions**

There are various pathological conditions of a stallion’s scrotum which can significantly affect a future breeding potential of the affected individual. Therefore, new diagnostic and treatment protocols for these problems should be investigated.
Further reading

Loss of libido - how to cope!

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Introduction
A stallion should become interested in a mare in oestrus immediately and interact with vocal, olfactory and tactile investigation. He will achieve an erection very quickly, within 2 min of contact, and be ready to mount soon after this. Once mounted, he will enter the mare and begin thrusting. After 6–8 intravaginal thrusts most stallions will ejaculate. The stallion will usually ejaculate on the first mount with a total breeding time of 2–5 min. A novice stallion that has never mated before may take longer to mount and gain intromission. He may mount the mare before gaining an erection or mount inappropriately from the side; he will, however, display good libido. The characteristics of a particular stallion’s reactions are dependent upon previous breeding experience, management and season. Some stallions breed efficiently with little contact with a mare, others require considerable teasing time.

Libido problems
Specific libido problems include slow starting novices, slow or ‘sour’ experienced stallions and specific aversions or preferences.
In a summary of 250 cases of sexual behaviour dysfunction by McDonnell (1992), libido problems accounted for 50% of cases. Of these 26% were slow starting novices, 12% were experienced stallions with inadequate libido and 12% were unruly or over-aggressive breeders. The other 50% of behaviour dysfunctions were: erection problems 5%, mounting problems 6%, ejaculatory dysfunction 25%, sexual aggression and fertility limiting general behaviour problems 14%.

The novice stallion
Slow arousal and awkward approach occur regularly in the novice stallion. Some may require considerable time to achieve erection and mount; however, they quickly gain confidence after a positive copulatory experience, especially when ejaculation is achieved. Some stallions may take several sessions to gain confidence and it is during this time that a handler’s impatience or rough handling can create a dysfunction. Unnecessary punishment during this learning phase may lead to a profound disininterest in breeding.

Many young stallions are involved in competition and managed in yards where normal sexual behaviour such as vocalisation, interest in mares, erection and masturbation are discouraged, often with punishment. The potential downside to such ‘negative conditioning’ is suppression of libido (McDonnell et al. 1985; McDonnell and Hinz 2005). This makes it all the more difficult to then encourage such behaviour when presented with a mare in oestrus, leading to fear and confusion. In addition, previous administration of drugs to control sexual behaviour may suppress libido. Administration of oral altronegost (Regumate™) at 0.088 mg/kg bwt for 8 weeks suppresses testosteronere levels and sexual behaviour (Brady et al. 1997). After cessation of treatment serum testosterone concentrations may take 4 weeks to return to pretreatment levels. Vaccination against GnRH using Equity™ (CSL Ltd., Australia) at intervals of 4 and 8 weeks have been demonstrated to suppress testosterone concentrations and libido in stallions lasting a minimum of 6 months (Janet et al. 2009).

The experienced stallion
In the case of the more experienced stallion, inadequate libido can be due to previous negative experiences. Inconsistent handling can lead to confusion with the stallion becoming disinterested. Some stallions, after long periods of consistent performance, develop poor libido or ejaculatory dysfunction, others develop problems after injury. Musculoskeletal pain resulting in difficulty in mounting may also inhibit libido if not addressed and managed appropriately. Some stallions may become frustrated and aggressive towards the mare or handler, whilst some may develop specific aversions or preferences. In extreme cases a stallion may become rigidly fixed to a specific routine (ritual bound).

Investigation of poor libido
In order to determine the nature of the problem it is important to take an accurate history to reveal any man made issues. It is important to perform a thorough physical examination as described by Crabtree (2010), in order to determine any physical problem which may lead to pain or discomfort, especially that which may be exacerbated by breeding. Then assess the stallion’s libido when presented with a mare in oestrus. Some stallions have an aversion to human intervention with an artificial vagina and so allowing the stallion to mount and copulate with a mare, suitably screened for disease, will help with assessment. Video recording can be useful to point out observations to the stallion handler and will record time.

Management of poor libido
Novice stallions benefit from minimal restraint and exposure to an older solicitous mare. Developing a regular breeding routine with an experienced and patient team can overcome many issues. Stallions with experience related libido problems often respond to behaviour therapy alone. Often this involves education or re-education of the stallion handler as well as the stallion. Continued exposure to mares and reduced exposure to other stallions will increase libido and androgen levels (McDonnell 1995).

Pharmacological manipulation to stimulate libido should be considered a last resort. To reduce anxiety in cases of experience induced libido problems use 0.05 mg/kg bwt diazepam (slow i.v.) 5 min prior to breeding. To temporarily boost libido one can use 50 μg gonadorelin (Fertagyl) SC 2 and 1 hours before breeding.

References


New developments in ultrasound evaluation of the stallion's reproductive system

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Ultrasound techniques have been used to evaluate the scrotum and internal genitalia in stallions for many years. Greyscale ultrasonography is a reliable tool for imaging testicular parenchyma, vaginal tunics, spermatic cord and epididymides. It allows accurate measurement of testicular dimensions important for calculating testicular volume, and expected daily sperm production. Pathological changes of the stallion testis, such as testicular tumours, hydrocele/haematocoele, inguinal hernia and torsion of spermatic cord can be visualised using ultrasonography. More recently, developments with colour-flow Doppler have provided useful information regarding normal and abnormal blood flow to the testis.

Colour Doppler ultrasound

Colour Doppler ultrasonography (CDU) of the stallion testis was introduced into veterinary practice several years ago. The technique is very useful for visualising the testicular vasculature in stallions and obtaining objective measures of testicular perfusion. We have described the application of this technique in detecting impairment of testicular blood flow in ageing stallions, in cases of mild torsion of spermatic cord and in severe hydrocele. Increased resistivity of the blood with obvious reverse blood flow in diastole was clearly seen in all cases. More recently, CDU and power Doppler imaging was used for monitoring changes in various scrotal pathologies, following physiological changes in testicular perfusion affected by season, as well as in detecting the effects of various treatments on testicular blood flow in stallions. This technique is a leading diagnostic method in assessing the degree of impairment of testicular perfusion, especially in cases with torsion of the spermatic cord. Clinically significant rotation of a scrotal testis is not as common in stallions as it is in man. Veterinary surgeons do not attempt salvaging affected testes due to the concern of potential damage to the contralateral testis. The breeding stallion has to produce large quantities of spermatozoa so that the concern of potential damage to the contralateral testis is not as significant. The testicular blood flow in the breeding stallion is usually functional and has a transient nature.

Theriogenologists often see stallions which have a tendency to develop occlusion of ampullae at the beginning of each breeding season. The majority of these can be successfully treated with oxytocin injection, transrectal massage and frequent multiple ejaculations. Common changes in semen include transient azoospermia, oligospermia or oligoasthenospermia. In some cases, accumulation of spermatozoa in the distal aspect of semen excurrent system in stallions may lead to formation of hard plugs which may occlude deferent ducts. These plugs, as well as dilation of the terminal, ampullary portion of deferent ducts, can be visualised using TRUS. In addition, TRUS is often used in monitoring any changes in degree of dilatation of ampullae of deferent ducts after treatment and ejaculation. This modality has been useful in detecting the presence of various cystic structures in the pelvic region of the stallion.

The most common cystic structure seen in the stallion using TRUS is the _uterus masculinus_, which is a remnant of the Müllerian duct. This cystic structure is often seen between the terminal parts of ampullae and usually does not pose any problems. However, occasionally, it may be large enough to affect the processes of emission and ejaculation. We have recently described cysts detected in the pelvic urethra, caudal to the terminal portion of distal ampullae of the vas deferens. Subsequently, we have shown that this cyst is located exactly at the _colliculus seminalis_ and may be a cause of EDO in stallions. We have seen a number of stallions with these cysts presented to our clinic. There were cases where this was only an incidental finding during a routine BSE, not associated with any ejaculatory problems. However, there were also some stallions with fertility problems, associated with poor semen quality and no other abnormalities found during clinical evaluation than midline prostatic cyst. The effectiveness of transurethral surgical procedures correcting physical obstructions of the ejaculatory ducts should also be explored in order to add to our treatment options for stallions with severe ejaculatory problems due to physical causes.

In summary, there continues to be progress in the development and application of various diagnostic and treatment techniques in human and veterinary andrology. ‘Human’ andrologists and equine theriogenologists should continue working on new developments in clinical andrology in addition to the new developments in semen analysis and processing.

Further reading


Proceedings of the 49th British Equine Veterinary Association Congress

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Twin management in mares

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Twins are avoidable and should not persist on well managed breeding farms. Clients understand this and demand the most sophisticated management programmes available. This presentation will focus on the routine twin management techniques on breeding farms and expected results and, as the hospital is a major referral centre that each year is presented with multiple referral cases of twin pregnancy that are diagnosed after cessation of the mobility phase, we will discuss management of these much more difficult cases.

Historically, twins have been the single most important cause of abortion. With the advent of ultrasonography the incidence of abortion associated with twins has decreased dramatically to less than 5% of all abortions. However, twins are often disastrous financially. Most twin pregnancies terminate in early fetal resorption or loss, late term abortions or the birth of small growth retarded foals. Mares aborting twins in late gestation frequently have foaling difficulties, damage their reproductive tracts and are difficult to re-breed. If foals are born alive they are frequently small, demonstrate the effects of intra-uterine growth retardation and have a poor survival rate with many needing expensive sophisticated critical care.

It is our responsibility to successfully manage early pregnancies such that no mare delivers or aborts twin foals. In consultation with farm managers, owners and clients we must utilise available equipment and technology commensurate with economic constraints and other owner/manager preferences to diagnose twin pregnancies as early as practically possible. It is also the responsibility of the veterinary profession to adequately inform owners/managers/clients of reasons why twins may not be diagnosed. Twins are still occasionally missed despite multiple examinations. Reasons why twins may not be detected will be discussed.

The mare is generally efficient at reducing unilateral twins to a single pregnancy. This is done by a competitive absorption of nutrients related to size and position of the early pregnancy and later to orientation of the embryo proper within the developing conceptus. However, a decision not to intervene needs to extrapolate the probability of successful reduction based on the age of identification, the orientation and fixation of the vesicles and any disparity in size. It is not considered good practice to leave twin pregnancies alone in the prefixation period unless one or both are too small to manipulate.

The probability of a mare losing one or both vesicles of a set of twins from identification to fixation is minimal and approximates that of early embryonic death for the same time period (per vesicle).

Twin or multiple pregnancies recognised prior to the day of fixation should be reduced to a singleton as soon as practically possible. As smaller than expected single pregnancies have a higher rate of early embryonic death, management techniques should consider the destruction of the smaller vesicle.

It should be noted that our philosophy is that ‘nonintervention’ is only acceptable when twins are diagnosed as a unilateral occurrence between Days 17 and 60 and then the decision for intervention depends on factors such as the value of the foal, the potential for rebreeding (endometrial cup formation, stallion availability, etc.) and the ability of the veterinarian to manually intervene. Intervention in twin pregnancies is strongly recommended in all other circumstances. When bilateral twins are diagnosed after Day 16 then destruction of one should be attempted as soon as possible. Intervention must occur before Day 35 if endometrial cup formation is to be prevented and immediate re-breeding is contemplated.

In early pregnancies (<Day 16), the technique we prefer is to use the probe to manipulate the vesicles while keeping one or both vesicles in view during the manipulation and, more importantly, the crushing or rupture of the vesicle. Utilising this technique it is possible to more accurately and quickly separate vesicles. Separation of vesicles should always be possible if the vesicles are still able to be identified as 2 spherical noncoalesced structures. Briefly, a finger is placed on either side of the probe to help stabilise the vesicle to be moved. Gentle side-to-side movement of the probe with pressure results in the 2 vesicles becoming separated. The separation is identified by lack of a vesicle under the probe (just the homogenous grey of the uterus). The vesicle can be crushed as close as 5 mm from each other but it is generally best to separate at least 20 mm. This is in case the mare moves at the time of increasing pressure. The vesicle is crushed by gradually increasing the pressure using the probe. Occasionally, refractory cases may need a sudden increase in pressure much like a quick flick or snap at the end of the probe. This later technique is quite useful for smaller (Day 11–13) vesicles.

At the GVEH in 2000, records were evaluated for 1716 Thoroughbred (TB) mare cycles and 1294 Standardbred (STB) mare cycles. Twins were diagnosed in 245 of 1716 cycles in TB mares (14.3% of cycles) and 46 of 1294 of STB cycles (3.5%). After twin reduction, mares are not routinely examined until the next scheduled examination i.e. 21–25 days post ovulation (detection of the fetus). When mares were re-examined after prefixation embryonic reduction of a twin, 10/245 TB mares (4%) had lost the remaining pregnancy and 8/46 STB mares (17.4%) were not pregnant. The number of TB mares losing the remaining pregnancy (4.0%) is similar to 3.7% (63/1716) which was the measured rate of early embryonic death (EED) on the same farms for mares with a single pregnancy diagnosed at Day 13–15 and then subsequently found to be empty at the next scan.

A further study from the GVEH published in 2010, demonstrated that between detection and Day 45 there were significantly fewer embryonic losses in mares diagnosed with multiple pregnancy and managed by crushing prefixation (29/633, 4.6%) compared to singleton pregnancy EED (408/5414, 7.5%, P = 0.004).
It is our contention that the procedure has developed to the stage that it is always expected that a single pregnancy will exist after prefixation embryo reduction is attempted. Unless a mistake occurs and the other vesicle is ruptured at the time of initial manipulation, we feel that any failure to survive the procedure is more likely a result of uterine inflammatory changes and infection or an embryonic defect rather than a result of the procedure.

Management of twin pregnancies after fixation is a much more difficult task. Excellent results can be achieved but only by combining knowledge of expected outcome with minimal intervention with abilities and recognition of susceptibility of the pregnancy to different techniques at different ages. For instance, at Day 45 in bilateral twin pregnancies, it is best to attempt to dislodge the fetus from the umbilicus by an oscillation technique; however, this technique is not appropriate in unilateral pregnancies, rather a membrane slipping technique is utilised. Similarly, fetal head dislocation through a standing flank laparotomy is a reliable technique around Day 60; however, transabdominal fetal injection of penicillin is more reliable after Day 100.

NOTES
Multiple pregnancy in women is a situation of increased risk in clinical obstetrics. Twin pregnancies are at increased risk of many adverse outcomes of pregnancy, including intra-uterine fetal death, congenital abnormality, preterm birth and complications during labour and delivery. A major determinant of the risks in twins is the chorionicity of the pregnancy. Dichorionic (DC) twin pregnancies may be monzygotic or dizygotic. However, monochorionic (MC) twin pregnancies are almost invariably monzygotic. Approximately 10–15% of MC pregnancies are complicated by twin-twin transfusion syndrome, where there is net transfer of blood from one twin (the donor) to the other (the recipient) across placental anastomoses. The clinical management of DC and MC twins will be summarised and some research issues will be highlighted.

Further reading
Caudal reproductive tract surgery in mares

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The procedures discussed represent techniques used at the Goulburn Valley Equine Hospital and are practical techniques that work well for us. Many different methods are employed successfully by others and some of the techniques presented are modifications of existing techniques, newer techniques and/or areas we feel warrant special attention.

The conditions described will be commonly seen by a busy equine practitioner during the course of a breeding season. Most of the techniques are directed at restoring or improving fertility. Most are elective procedures, but require experience in order to make the correct diagnosis and institute the best therapeutic approach. Our experiences have led us to prefer the techniques to other published alternatives.

Patient selection
Care should be exercised to select only those candidates that are likely to respond favourably to surgery.

The probability of a successful outcome and subsequent production of a live foal must be evaluated with regard to:

a) Severity and nature of the problem
b) Breeding history of the mare
c) Value of the mare and/or offspring (commercial or sentimental)
d) Cost of the procedure
e) Mare age
f) Fertility of the stallion
g) Availability and suitability of assisted breeding techniques such as artificial insemination (AI) or embryo transfer (ET) etc.

h) Long-term predictive value of surgical intervention, e.g. temporary or permanent improvement
i) General health of the candidate
j) Perpetuation of heritable conditions
k) Insurance status and informed client consent
l) Ethical considerations
m) Experience of the veterinarian
n) Quality of on-farm management
o) Previous attempts at repair of the problem

Epidural anaesthesia can be extremely effective, however variation in response, individual susceptibility and time before appropriate anaesthesia is obtained, occasionally make it less rewarding than tranquillisation and local infiltration for some of the procedures discussed here. For epidural anaesthesia we prefer the following mixture: xylazine (~0.17 mg/kg bwt), lidocaine (~0.15 mg/kg bwt; ~3ml of 2% lidocaine solution) and ~6 ml of Lactated Ringer’s solution to a volume of 10 ml. The volume administered as an epidural in the first intercoccygeal space is titrated based on the size of the mare. Large mares (>600 kg) may receive the full 10 ml dose and smaller mares (450–500 kg) receive between 7–8 ml. With this regime, loss of tail tone has occurred in association with a successful ‘block’ within 5–10 min, and surgery generally has begun by ~20–30 min post administration. Our most commonly used method of epidural anaesthesia is to begin with the infusion 1 ml of local anaesthetic through a 25 gauge needle subcutaneously above the first moveable coccygeal/sacral joint (usually C1 and C2). Next, a 38 mm, 18 gauge needle (bevel forward or up and introduced at 45° to the skin) that has a small amount of anaesthetic solution to create a meniscus on the needle hub, is introduced through the local bleb. Recognition of the fluid being aspirated into the needle infers correct placement and the appropriate amount of solution is injected slowly into the epidural space whilst continually evaluating the ease of administration to ensure the needle tip is still in the appropriate place.

In this presentation, due to time constraints, only the following conditions and their surgical management will be discussed.

- Urovagina
- Recto-vaginal fistula
- Third degree perineal lacerations
- Perineal body repair

Urovagina
The surgical technique has not changed significantly since our original technique was published in 1988; however, our management of the condition has. The surgery has classically been left to the end of the season in barren mares identified as having urovagina during the breeding season. Recently we have bred mares during the same breeding season in the cycle immediately after repair or have bred mares prior to repair (immediately after identification of urovagina) and then performed the surgery within 48 h of breeding. The latter group requires evacuation of any urine with a large tampon immediately prior to service. When mares were bred in the same cycle as surgery; the first cycle following surgery, second cycle following surgery or the following breeding season after surgery the seasonal pregnancy rates were 89% (8/9), 63% (10/16), 67% (2/3) and 63% (15/24), respectively. After removing 4 mares that died of natural causes prefoaling, the foaling rates were 88% (7/8), 50% (7/14), 0% (0/3), 52% (12/23), respectively. All mares bred in the same cycle or next cycle as surgery were bred once only that season, and thus the pregnancy rate per cycle of 72% (~18/25) was identical to the expected seasonal pregnancy rate per cycle.

Fistula formation has been noted as a problem. In all cases fistulas occurred at the junction of the “Y” shaped incision and...
were repaired successfully in standing sedated mares. The mean age of mares with fistula formation was 16 years (median 17 years). Six of the 61 cases in this series were referred to our facility for surgery following previous unsuccessful attempts at uro vagina correction. Four of the fistulas identified were in this population of mares which had previously undergone an unsuccessful surgery. In addition these were the majority of mares (3/5, 60%) which had a continuation of urovagina after the initial surgical repair. Of the 7 mares in which fistula formation occurred, 5 were corrected following a single surgery; 2 mares required 2 surgeries to correct the fistula.

**Recto-vaginal fistula (RVF)**

Many surgeons treat RVF by converting them to 3rd degree PL and repairing either standing or under general anaesthesia. For deep (cranial) RVFs a perineal body transection has been utilised and recently a pedicle flap has been described. During the past 2 decades we have repaired RVF with a transrectal approach, which we first described in 1991. In our hospital, Aanes modified Finochetto retractors are inserted into the rectum through the anal sphincter. These retractors make the surgery quite simple.

We have reported on breeding the mares on an induced (prostaglandin) second post partum oestrous period and then immediately (within 2 days) performing the fistula repair. When mares were bred in the same cycle as surgery, the next cycle following surgery or the following breeding season after surgery the pregnancy rates were 5/5, 5/6 and 10/12, respectively. Foaling rates were 4/5, 4/6 and 7/12, respectively. Two mares already pregnant at the time of surgery foaled successfully. For breeding immediately prior to surgery to be successful, as much faecal material as possible is removed immediately before breeding (either natural or AI). After breeding the uterus is lavaged at least daily until repair is performed.

**Third degree perineal lacerations**

These result in tearing of the vestibular and sometimes vaginal wall and disruption of the perineal body, anal sphincter and rectal wall. This results in a common opening between the rectum and the vestibule.

The surgical correction is delayed at least 4 weeks to allow second intention wound healing to occur. The longer the injury is left untreated the more opportunities for continual contamination of the reproductive tract; however, this is related to functional capabilities of vestibular sphincter. The cervix must be examined prior to surgical correction of PL and if a prolonged time between foaling and repair has occurred a full reproductive evaluation including a uterine biopsy is warranted.

There are many methods described. A modification of a single-stage repair is the technique we prefer. Prior to surgery, vigorous efforts are made to modify the consistency of the faeces. Mares are held off feed for at least 24 h and given a mineral oil drench (2–3 l) immediately before or after surgery. Following surgery, mares are placed on pasture if available and mineral oil is administered by nasogastric tube daily for 3 days as necessary to maintain a soft faecal consistency.

The repair is straightforward as previously described except that there has been little discussion on suture tensions and methods to modify it. We have developed a new technique that creates the perineal body with less side to side (lateral to medial) tension. The technique aims to create the tension in a transverse/dorsal-ventral orientation similar to the tensions with recto-vaginal fistulae (see below). The suture pattern is a simple continuous pattern apposing dorsal rectal submucosa to dorsal vaginal/vestibular submucosa (ventral wall of the perineal body) from the lateral border of the perineal body, through midline to the opposite side and back again. It is frequently necessary to tie and begin another new suture as the pattern will result in use of as much as 2 or 3 packets of 2 PDS.

Following surgery, management of faecal consistency is critical.

**Perineal body repair**

This procedure is used in cases with more severe anatomic abnormalities where the Caslick vulvoplasty is ineffective and in mares with extensive or repeated second-degree perineal lacerations. The surgery is an episiotomy and is used to describe the more extensive procedure previously referred to as 1) a deep Caslick, 2) the Gadd technique, or 3) perineal body reconstruction, or perineoplasty. The procedure is designed to restore some degree of function to the perineal body.

The surgery is performed on the standing mare using local anaesthesia or, occasionally, epidural anaesthesia.

A triangular portion of the dorso-caudal mucosa is removed from both sides of the vestibule. The ventral borders are apposed with a simple continuous suture pattern using an absorbable material (2/0 polydixanone [PDS] or chromic catgut), and dead space with single interrupted or simple continuous sutures of the same material. The muco-cutaneous junction is closed in a similar fashion to the Caslick’s operation. Apposition of the ventral borders of the incision and obliteration of the potential space above, result in an increase in size of the perineal body and decreased propensity of the vestibule to expand and generate negative pressure.
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Friday 10th September 2010

Reproduction Core Skills
Chaired by Sandro Barbacini

16.30–16.50
How to manage the mare for artificial insemination with chilled or frozen semen

Caroline McGregor Argo
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Introduction
In racing Thoroughbred circles, artificial insemination (AI) is rapidly gaining favour as the breeding method of choice. Health and safety benefits are well-recognised and per cycle conception rates with fresh and chilled semen, often equal or exceed expectations from natural service. Logistic conveniences offered by frozen semen often compensate for slight decreases in per cycle conceptions (5–10%). Many advantages of AI are linked to the more intensive reproductive management of mares. Successful AI depends on a solid understanding of oestrus cycle physiology, good records and communications and above all, attention to detail.

Considerations
Upfront, it is important that mare owners appreciate their role in arrangements and costs associated with the acquisition of semen.
- For chilled, shipped semen, restrictions on stallion availability, ordering requirements, associated costs and any insurances should be understood.
- Semen in freezing allows semen demands excellent facilities.
- Costs can be high and nonredeemable. Thorough evaluation of mare breeding prognosis at outset saves expense and disappointment.

Serial reproductive examinations carry significant risk. The restraint of mares in stocks should be prioritised.

Prebreeding evaluation of mares
Frozen semen should be reserved for the best mares. The decrease in fertility with frozen semen is compounded when other adverse factors, including age, equivocal breeding histories and reproductive deficits, are present.

General and reproductive health should be carefully evaluated. Conformational deficits in genitalia should be identified for correction and the reproductive tract rigorously appraised by transrectal palpation and ultrasound imaging. For older animals, those with poor breeding histories or where uterine abnormalities are suspected, endometrial biopsies and swabs usefully inform breeding prognoses and remedial interventions. Small, sparse, endometrial cysts rarely inhibit breeding but their distribution within the uterus should be mapped to aid pregnancy diagnosis later. Ovaries are appraised for normality of size and evidence of cyclic activity. An aseptically-conducted vaginal examination confirms vaginal/cervical integrity and tone.

If all is well, where chilled semen is intended, the stallion stud should be informed of the mare’s submission. Mare identity must be confirmed and a copy of the passport retained.

Staging the oestrus cycle
On presentation of the mare, her position within the oestrous cycle is estimated using all available indicators (uterine tone and oedema score [0 = none to 4 = maximal], follicular sizes and corpora lutea [CL], cervix tone). All observations and treatments must be clearly recorded to allow accurate monitoring of subsequent change.

Advancing oestrus
A single, intramuscular dose (250–500 μg) of the prostaglandin analogue (PG) cloprostenol, remains the most commonly used luteolytic protocol. Efficient luteolysis is dependant on the presence of PG receptors in the CL. With a ~15 day luteal phase, a third of mares in dioestrus on first appraisal will have young (<5 days), potentially unresponsive CLs. Mares should be retreated within 2–3 days if required.

Monitoring follicular growth
Individuals vary widely in the timing of ovarian changes following cloprostenol administration. While mare entry to heat within 3 days of treatment is commonly quoted, in practice this ranges between 1 and 10 days. Ovarian follicles grow considerably during dioestrus. Estimates of the time required for follicle(s) to reach a size sufficient to induce ovulation (>30 mm diameter) are obtained by recording follicle size(s) at the time of PG treatment. Follicles exceeding 25 mm (ponies, >20 mm) are considered dominant (likely to ovulate). From this point, follicular growth has been estimated at ~3 mm/day. Follicular growth should be monitored until follicle diameter(s) first exceeds 30–35 mm, when receptors for the natural ovulation trigger, luteinising hormone, should be present.

Induction of ovulation
Induction of ovulation allows the optimal timing of insemination to be predicted. When chilled, shipped semen is intended, availability of semen for the following day should be confirmed before ovulation is induced. Two protocols are currently used.

a) Intravenous infusion of human chorionic gonadotrophin (1500–3000 iu hCG [Chorulon, Intervet]), when follicle(s) first exceed 35 mm diameter AND uterine oedema (3–4) and a soft cervix are also present. Ninety percent of mares ovulate within 48 h (average 36 h).

b) Subcutaneous implantation (2.1 mg) or i.m. injection (1–2 mg) of a GnRH agonist (deslorelin [Ovuplant, Dechra Veterinary Products]), when follicle(s) exceed 30 mm diameter AND some uterine oedema is noted. Ninety percent of mares ovulate within 36–42 h of treatment.
Timing of insemination
For chilled semen, conception rates are greatest when insemination is within the 24 h preceding ovulation. The relatively short life (12 h) of frozen semen requires that mares are inseminated immediately before (within 6 h) or after (within 4 h) ovulation. If 2 frozen semen doses are available, fixed-time inseminations at 24 h and 36–40 h post hCG treatment will reduce scanning requirements.

Preinsemination
Cross-check paperwork associated with the mare and semen. Chilled semen must be evaluated using a warm-stage (37°C) microscope immediately before insemination. In general, more than 40% of spermatozoa should be progressively motile (PM). Some fertile stallions consistently score less but this information should be offered. Semen evaluations should be reported to the stud. By necessity, remnants of frozen inseminates are appraised post insemination.

Insemination
Mares should be re-scanned to a) evacuate faeces, b) ensure persistence of the dominant follicle and c) to ensure that free fluid has not accumulated in the uterine lumen. The perineum is thoroughly cleaned (dilute chlorhexidine) and rinsed with water. A sterile sleeve and nonspermicidal lubricant are used to introduce the insemination catheter tip into the uterine body per vaginum. Inseminates (~500 million PM sperm, <60 ml) are infused gently. Individually thaw frozen straws as directed (generally 30 s in a 37°C water bath) and unless very low volume (<1 ml), straw contents are usefully pooled (37°C) and inseminated as for chilled.

Post insemination check
Should be conducted 24 h after insemination to confirm ovulation and to detect any persistent fluid in the uterine lumen. Dependent on fluid depth (<10 mm or >10 mm), fluid accumulations should be treated with oxytocin (20 iu, i.m) or a combination of saline lavage, antibiosis and oxytocin. Treatments should be repeated until no free fluid remains. Mares which have not ovulated within 36 h of chilled semen insemination should be rebred.

Further reading
Management of the mare in the post breeding period

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The period immediately following breeding of the mare by either natural service or artificial insemination is very important and appropriate management can make a significant contribution to fertility. Good mare management practices should be combined with veterinary examination to achieve optimum fertility. The most important measures which can be taken are those which contribute to the restoration of a normal uterine environment as soon as possible after breeding.

Farms should tease mares with a stallion in the post breeding period to identify abnormally prolonged oestrus (secondary follicles) and stimulate endogenous oxytocin release. Adequate exercise after breeding also promotes uterine clearance and prevents vaginal urinary reflux. Unfortunately recent trends in mare management often involve housing maidend/barren mares in early spring with only short periods of horse-walker exercise. It is important to ensure that mares with foals at foot receive as much paddock exercise as possible.

Veterinary examination following breeding is usually carried out at 48 h and should include a careful examination of the external and internal genital organs. Attention to detail is essential.

External inspection will assess the effectiveness of the vulval seal and note whether any Caslick suture requires repair. Inflammatory discharge on the vulva, thighs or tail hair indicates a problem. It is important to ensure that mares with foals at foot receive as much paddock exercise as possible.

Ultrasound examination of the ovaries allows confirmation that a normal ovulation has occurred and is timed appropriately in respect of breeding. With natural service or chilled semen examination is usually made at 48 h after breeding unless sperm longevity is poor in which case 24 h is preferable. Following insemination with frozen semen, ovulation is desirable within 6 h. Instances of multiple ovulation (risk of multiple conception) or abnormal/fanovulation should be noted.

Evaluation of the uterus by ultrasound is of major importance after breeding, allowing the detection of intra-luminal fluid accumulation indicative of poor uterine clearance/post mating endometritis.

Arguably post mating endometritis and its adverse effects on the uterine environment can be regarded as one of the most significant causes of reduced fertility. It must also be recognised, however, that gross clinical signs of post mating endometritis (discharge/intra-luminal fluid) are likely to be appreciable in only a small proportion of cases - the majority being subclinical and difficult to detect.

The recognition and careful management of mares affected by post mating endometritis can potentially contribute to major improvements in mare fertility. Treatment and prophylactic protocols have developed based on a combination of principles related to the reproductive physiology of the mare and practical experience.

It is known that the equine endometrium mounts an acute inflammatory response to breeding. Ejaculation takes place directly into the uterus at natural mating and large numbers of bacteria are inevitably introduced. In the normal mare the resulting response involves the release of inflammatory mediators and chemotactic attraction of neutrophils. Local prostaglandin release provokes increased myometrial contraction to aid transcervical clearance of inflammatory debris. Introduced bacteria are inactivated within 5 h and the acute inflammatory response resolves within 24–48 h.

Unfortunately, a proportion of mares exhibit an increased susceptibility to mating-induced endometritis and appear unable to resolve the inflammatory process. Research indicates that, although the initial response is similar to that in resistant mares, the inflammatory debris is not expelled from the uterus due to a defect in myometrial activity and the physical clearance mechanism. The persistence of mating-induced endometritis will compromise the uterine environment making it incapable of supporting the development of the early pregnancy on arrival after the oviducal transport phase (5.5 days).

A similarly persistent inflammatory response may be provoked by frozen semen where, to allow cryopreservation, the absence of seminal plasma leads to a reduced modulation of neutrophil function and induced endometritis.

Typically, mares which are susceptible to mating-induced endometritis may be difficult to identify on initial examination but have a history of apparent failure to breed over successive oestrous cycles. Such mares are middle-aged, show age and parity related conformational changes in the genital tract and degenerative histological changes in the endometrium.

Management protocols which have proved most successful in the treatment of post mating endometritis are those which address the primary defect - the failure of physical clearance of inflammatory debris from the uterus within 24 h of breeding and restoration of the normal uterine environment prior to the arrival of the early pregnancy at Day 5.

Treatments are largely based on the use of isotonic fluids (normal saline or Hartmans) for uterine lavage, intra-uterine infusion of antibiotics and ecbolic agents (oxytocin or carbetocin) to stimulate myometrial contraction. There is, however, considerable variation between clinicians - the preferred practical approach is often derived from personal experience rather than published material.

Uterine lavage is performed with a wide bore sterile tube to which 1 l fluid bags are attached. The contents of each bag can be squeezed in and then retrieved allowing inspection of the contents of each bag can be squeezed in and then retrieved allowing inspection of the

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Uterine lavage is performed with a wide bore sterile tube to which 1 l fluid bags are attached. The contents of each bag can be squeezed in and then retrieved allowing inspection of the contents of each bag can be squeezed in and then retrieved allowing inspection of the...
How to scan a mare for pregnancy diagnosis

Caroline McGregor Argo
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Introduction
Early and accurate pregnancy diagnosis is an important for efficient stud management for 3 key reasons.
- The high value of early-born foals requires that empty mares are rapidly rebred.
- Nonviable pregnancies must be detected and aborted before Day 35 when hCG secretion from the endometrial cups will prevent rebreeding.
- Manual reduction of multiple pregnancies is most successful before embryo fixation occurs around Day 16 post conception.

Ultrasound in pregnancy diagnosis
Currently, these requirements can only be met by trans-rectal ultrasound imaging. Although pregnancy can be detected by trans-rectal palpation from Day 30–40 post conception, this incurs significant delays in rebreeding empty mares and can neither reliably identify twins nor appraise embryo quality. Ultrasound imaging transformed stud medicine, almost halving abortion rates alone through the identification and reduction of multiple pregnancies (McKinnon 2010).

The equine embryo
The spherical equine morula/blastocyst (1 mm) enters the uterus between 5–6 days after conception and expands rapidly to a diameter (5 mm) detectable by most scanners (5–8 MHz) by Days 11–12. The encapsulated blastocyst grows and moves freely within the uterus. Endometrial attachment, generally at the caudal limit of a uterine horn, occurs ~Day 16. The capsule is lost (Days 18–22) and vesicle growth is temporarily arrested (Days 17–26). As the underlying allantoic cavity develops, the embryo is progressively lifted from the ventral pole of the vesicle (Day 25, heartbeat first detected), to occupy an equatorial position by Day 30. Over the next 10 days, the yolk sac cavity is gradually displaced by increasing volumes of the supporting allantoic cavity. By Day 40, the yolk sac is lost to imaging, allantoic membranes fuse to form the early umbilical cord and the fragile amniotic membranes become evident.

Approach to scanning the mare
A systematic approach is essential. The scanner head is advanced cranially along the uterine body and on reaching the uterine horns, endometrial oedema (0 = none to 4 = marked) is scored. The scanner head is moved laterally along one horn the ovary visualised. Corpora lutea should be noted. Re-direct the scanner back along the horn, pause to inspect the uterine bifurcation, before examining the contralateral horn and ovary. A final perusal of the uterine body ensures that the entire uterus has been viewed at least twice.

When to scan?
Practices differ in exact dates used for routine scans. At least 2 scans are required. Although the blastocyst can be imaged at Day 11–12, scanning should be delayed. Small embryos are easily missed and a second, younger/smaller blastocyst will go undetected. The first routine scan is performed ~Day 15 post ovulation/insemination. This allows prompt identification/reduction of multiple pregnancies and ensures empty mares are rebred on their imminent return to oestrus. The presence/viability of a single pregnancy is confirmed ~Day 30 before endometrial cup formation precludes rebreeding. An intermediate scan (~Day 22–25) can be included and most practices advocate a further scan ~Day 42, in recognition that up to 15% of pregnancies are lost between Days 10 and 50.

Day 14–16 scan
Expanded blastocysts are highly motile but readily imaged. Yolk sac fluid, occupying the interior of the spherical (15–20 mm diameter) embryo, generates a characteristic circular, anechoic (black) appearance within the uterus. If no pregnancy is detected the scan should be repeated for confirmation.

Considerations:
- **Uterine oedema:** In late dioestrus no oedema is expected. Some oedema, local to the embryo is common. Generalised oedema is suggestive of pregnancy failure and a return to heat.
- **Multiple pregnancies:** Adherence to a systematic approach is essential for detection. When multiple corpora lutea are recognised, extra vigilance is needed. The ‘single’ conceptus should be scanned carefully to determine whether a second embryo is ‘hiding’ behind the first.
- **Embryo or cyst?** The circular regularity of the embryo outline and characteristic specular reflections (imaging artefacts), evident at the 'top and bottom' of the imaged embryo, help distinguish embryos from anechoic uterine cysts. Cysts are usually irregularly-shaped and lack specular artefacts. If in doubt, rescan the mare on successive days. While embryos grow in this time - cysts generally do not!
- **Embryo size:** Embryo diameter can usefully be compared to expected size:age ranges. Artificial insemination with frozen semen has been associated with a slight (~1 day) delay in embryo development but in other cases, small for age embryos are considered ‘high risk’ and their future development should be carefully monitored.
- **Uterine free fluid:** Free fluid in the uterine lumen should be noted but suggests a poor prognosis for pregnancy maintenance.

Day 28–30 scan
The embryonic capsule has been shed and the vesicle no longer maintains a precise, spherical outline. Grossly, the conceptus remains fluid filled and anechoic and the embryo within is imaged as a heterogeneous mass, suspended on a ‘vesicle bisecting’ sheet (line) of allantoic/yolk sac membrane, towards the centre of the conceptus. Patient imaging reveals the flickering embryo heartbeat.

Considerations:
- **Failure to detect the embryonic heartbeat** indicates pregnancy loss.
- **Failure to detect an embryo** may indicate an anembryonic vesicle (rare) but just occasionally the embryo is adherent to...
the outer embryonic membranes and a careful search should be made for the tell-tale heartbeat.

- Flocculent fetal fluids are suggestive of a compromised embryo. Pregnancy termination and rebreeding may be advised.
- Twin pregnancies, missed on the first scan should be identified and corrected now; easy if bilaterally fixed but requires rigorous attention if concepti are adjacent.

Further reading
Proceedings of the 49th British Equine Veterinary Association Congress
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Many of the problems commonly encountered during equine anaesthesia can be prevented by simple equipment checks before starting the anaesthetic. In veterinary anaesthesia it appears that any emergency procedures, regardless of the patient’s health status, carries a higher risk of mortality than elective anaesthesia and perhaps one cause is a lack of thorough preparation.

At the beginning of each day it is worthwhile to check the oxygen cylinders and also the anaesthetic machine, including the breathing system. Flowmeters should be turned on and off and should have free movement. If a leak is present then it is difficult to maintain a stable plane of anaesthesia whilst causing pollution to the theatre environment. This is done by closing the APL valve and occluding the patient end. The fresh gas flow is increased to inflate the bag until a pressure of 20 cmH₂O and then the fresh gas flow is turned off. The pressure within the circuit should be maintained if no leaks are present. If the pressure falls then a leak is present and needs to be identified before starting the anaesthetic. Various recommendations have been made for acceptable leaks (a fresh gas flow rate less than 0.25 l/min to maintain a pressure of 30 cmH₂O or a pressure drop of less than 5 cmH₂O in 30 s). The system can be pressurised higher by squeezing the reservoir bag and this is useful for identifying where any leaks are coming from (usually the soda lime canister or the bag). The APL valve can then be opened and the bag should deflate easily.

Checking that the unidirectional valves are functioning properly is more difficult in the equine machine but if there is a problem with the valves sticking then the capnograph should identify this once the horse is connected up (for example if the expiratory valve is stuck in the open position, rebreathing will be seen). The valves can be checked by connecting a rebreathing bag to the patient end of the Y piece connector and inflated. When this bag is squeezed, the expiratory valve should open and when released to inspiratory valve should open. Soda lime should be checked at the end of each anaesthetic, as well as checking for rebreathing on the capnograph. It must be remembered that soda lime can revert back to its original colour when left overnight and so it is better to check the area of soda lime generating heat at the end of the previous anaesthetic. If a ventilator is available, the breathing system can be swapped onto ventilator and again the patient end occluded. The ventilator can be started and checked that it cuts out at the given pressure, that the bellows fall back down and also the rate can be set.

Prefilling the circle system prior to commencing the anaesthetic can be performed by occluding the patient end, closing the APL valve and filling the system with isoflurane and oxygen. This will prime the breathing system, decreasing stabilisation time after the horse is connected and will enable lower fresh gas flow rates and vaporiser settings to be used initially.

The cuffs of the endotracheal tubes should be inflated to ensure they can seal the trachea and left for a period of time to ensure no slow leaks are present. The monitoring equipment should also be prepared and any equipment required for blood pressure monitoring set up.

Finally, the induction drugs can be prepared and the vaporiser checked. Any potential anaesthetic problems should be considered before induction and prepared for.

These simple checks can save time during an anaesthetic as well as minimising equipment problems.
14.25–14.50
Using our eyes: can intraoperative problems be detected early enough?

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One aim of the anaesthetist should be to ensure that the horse they anaesthetise recovers from anaesthesia in the same or better ‘condition’ than they were in before anaesthesia was induced. The main problems that concern us during anaesthesia are; is the horse too deep? Is the horse too light? Is the physiological status of the horse deteriorating?

Monitoring central nervous system (CNS) function during anaesthesia in the horse is a fundamental skill. This is for 2 reasons; firstly horses are incredibly sensitive to the cardiovascular and respiratory depressant effects of the inhaled anaesthetic agents and excessively deeply anaesthetised horses may have dangerously compromised physiology. Secondly, under inhaled anaesthesia, changes in anaesthetic depth are normally slow but if the horse reaches the threshold where sensory input permeates through anaesthesia to cause the horse to react purposefully, the reaction of the horse can be rapid, violent and dangerous to the horse, equipment and theatre personnel.

Objective assessments of ‘unconsciousness’ are possible in horses using electroencephalography (EEG) (Murrell et al. 2003) or EEG derived technology (bispectral index- BIS) (Yamashita et al. 2009; Beldao et al. 2010), but both these applications have limitations that mean they are unlikely to be used widely in clinical equine anaesthesia in the foreseeable future. Therefore, we rely on subjective assessment of CNS depression (e.g. reflexes, movement, sweating) or indirect objective physiological parameter monitoring (e.g. blood pressure, respiratory rate/pattern). During this presentation, I shall highlight my approach to CNS monitoring during anaesthesia. Both the subjective and indirect measures may be affected by other influences (e.g. drugs) further clouding the picture. It is imperative therefore that the anaesthetist arms themselves with as much information as possible when attempting to assess the level of consciousness, but, even then, some horses have the ability to progress from an apparently stable level of anaesthesia to vigorous purposeful movement before exhibiting any other signs of lack of CNS depression. It is for this reason even the most experienced equine anaesthetists always have some fast-acting injectable anaesthetic agents close at hand.

Nowadays, there is an impressive array of equipment available to facilitate accurate continuous monitoring of many cardiovascular and respiratory physiological parameters in the anaesthetised horse. Cost-conscious vets often question which piece of equipment is most useful, and that debate is outside the scope of this presentation. However, I would make the following 2 points. Firstly, any piece of equipment is only useful if it is used and maintained properly (including calibration) and if the people using it are able to interpret the information it provides. Secondly, the real value of physiological monitoring is in helping us to identify trends (i.e. coupled with anaesthetic records!). It is perfectly possible to miss a slow, insidious drop in blood pressure reflecting a deepening plane of anaesthesia (or worse) if one only occasionally glances at the screen and does not compare the data to those from previous epochs. In comparison a cursory glance at an anaesthetic record sheet allows the anaesthetist to instantaneously assess what is happening and what has been happening to the measured parameters.

Finally, it should also be highlighted that by observing the surgery/surgeon, the anaesthetist may also be able to predict/detect problems. One obvious example of this is significant and uncontrolled haemorrhage; another would be being aware that the horse is only ‘lightly’ anaesthetised and yet within the next 10 minutes you know the surgeon will be causing a profound increase in nociceptive input into the CNS of the horse. In either case the anaesthetist can start to take pre-emptive steps to ameliorate the potential problem.

To summarise, detecting problems in anaesthetised horses can be a challenge but having an observant, dedicated anaesthetist accompanied with an anaesthetic record dramatically improves the chances of auspicious problem detection.

References


References

Although equine pain management techniques still lag behind those practised in small animals, recognition of the advantages of adequate pain management for recovery and healing has resulted in promising research and publications. Understanding appropriate dosing and multi-modal anaesthetic techniques minimise the side effects associated with analgesics. Modern understanding of appropriate drug doses have aided in diminishing the stigma associated with administering medications like opioids and nonsteroidal anti-inflammatory agents (NSAIDs) to horses. Phenylbutazone and flunixin meglumine are still mainstays for pain management but we are now armed with new techniques like epidural and perineural catheters for constant local anaesthetic administration and alternative drugs like gabapentin and ketamine for dealing with significant or chronic pain. Clinically, it is becoming recognised that appropriately administered perioperative analgesics speed the recovery process by maintaining appetite and mobility.

Pain can be minimised in elective surgical procedures by the combination of good surgical technique, good anaesthetic technique (avoiding hypotension and hypoxaemia) and pre-emptive and post operative administration of analgesics. It is inappropriate to assume that a good analgesic plan will work if there is poor surgical and/or poor anaesthetic technique.

NSAIDs remain an important part of any analgesic plan and are effective in minimising inflammation that results in the release of neurotransmitters. Opioids are also useful as preanaesthetic analgesics. The most common include the short-acting kappa agonist/mu antagonist drug butorphanol, the partial mu agonist buprenorphine and the full mu agonists morphine, pethidine (meperidine), methadone and fentanyl contained in an adhesive topical patch.

For invasive procedures involving significant tissue and/or bone manipulation, perioperative administration of dissociative drugs like ketamine or the anti-epileptic drug gabapentin are recommended to minimise or prevent amplification of pain in the central nervous system. These drugs can be administered in combination with an NSAID, opioid or alpha-2 agonist.

Patients presenting for emergency procedures or with existing chronic pain can be challenging for the practitioner. The existing pain must be overcome by aggressive treatment prior to developing a maintenance analgesia plan that minimises side effects associated with the treatment. These patients are best managed by starting with a method of pain scoring to evaluate the base-line pain level with follow-up pain scoring to determine the effectiveness of treatment. Recommended methods that have been used in horses include the modified Glasgow pain scale or the modified composite pain score. Aggressive initial treatment for severe or chronic pain can be achieved with constant rate infusions or epidural placement of opioids, dissociative agents or alpha-2 agonists. In cases of peripheral pain, local blocks or perineural catheters can be placed for constant infusion of local anaesthetic.

Duration of post operative analgesic administration is dependent on the type of procedure performed and the response to analgesic agents administered. Long-term NSAID use should be combined with anti-ulcer medication and chronic use of opioids must be accompanied by diet change or pro-motility medications aimed at preventing gastrointestinal stasis.
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As an obstetric anaesthetist, my work is primarily focused on anaesthetising pregnant women for obstetric procedures, but I am also consulted on anaesthesia for pregnant women presenting for incidental surgery in pregnancy.

The pregnant state demands dramatic physiological compensation to adapt to the requirements of the developing fetus and to prepare for childbirth. These changes are evident from a very early stage in pregnancy and initially seem to be out of proportion to the size of the fetus. Changes are evident in most body systems and anaesthesia in pregnancy must take this into consideration. There are also important pharmacological considerations in the pregnant state, both with the handling of drugs and the choice of drugs in pregnancy.

There are different techniques for anaesthetising women for obstetric procedures and these are broadly divided into regional anaesthesia or general anaesthesia. The choice of anaesthetic technique depends on many factors such as the urgency for delivery, choice of labour analgesia and factors that may be absolute or relative contraindications to regional or general anaesthesia. The majority of obstetric surgical interventions are performed with women awake under either a spinal or epidural anaesthetic.

Challenges in obstetric anaesthesia include the management of pregnant women with significant co-morbidities such as cardiac disease. Cardiac disease is now a significant cause of maternal mortality in the UK. The physiological changes of pregnancy may result in decompensation in women with cardiac disease and the timing of delivery is dependent on a balance between fetal and maternal well-being. The rate of morbid obesity in women of child bearing age is rising at an alarming rate and managing these women on the labour ward can be very challenging.

Incidental surgery in pregnancy provides another anaesthetic challenge. There are many important considerations including positioning of the patient and monitoring of fetal well-being before, during and after surgery. Timing of surgery in pregnancy usually aims to avoid the first trimester at all cost. There is an association with early fetal loss and very small risk of teratogenic effects to the fetus. Regional anaesthesia is the method of choice if at all possible as it minimises the effects of anaesthesia on the developing fetus.
Anaesthetising the pregnant mare and techniques for caesarean operation

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Anaesthesia for pregnant mares
Anaesthetic challenge and risk increase throughout pregnancy and reach a maximum at term because of a) increasing fetal size and b) ongoing physiological adaptations in the mare. However, different problems exist in different trimesters; in people the risk of spontaneous abortion diminishes with gestation. The teratogenic effects of anaesthesia are theoretically greatest in the organogenetic stage (1st trimester) of pregnancy. Most drugs are unlicensed for use in pregnant animals, not because they are teratogenic, but because they have not been tested in pregnant animals. Despite its effects on nucleic acid synthesis, N2O is not teratogenic and is not contraindicated in the 1st trimester. As pregnancy enters the second trimester, adverse haemodynamic effects of anaesthetics (and surgery) on the utero-placental unit may lead to premature placental separation, i.e. abortion. This risk increases as pregnancy advances. Owners should be informed of this for medico-legal reasons. The combined risk to the mare and fetus is minimum during the second trimester, which is in theory the safest time for nonobstetrical operations. As pregnancy advances to term, rapid increases in fetal size and nutritional demand initiate major physiological changes in the dam. Other maternal changes occur in preparation for parturition itself. The net effect on the dam is a diminution of functional reserve and an increased risk from anaesthesia (see later). Much is made of the abortifacient effects of sedative drugs - particularly α2 agonists - and anaesthetics. However, endogenous glucocorticoids released in response to stress, i.e., anxiety/pain, inadequately anaesthetica/surgical stimulation/nociception, post operative pain, hypotension, hypoxaemia and hypercapnia also promote myometrial excitability. Consequently, adequate doses of theoretical abortifacient may be safer than inadequate doses that fail to prevent a stress response.

In the final analysis, standing surgical techniques, where appropriate, are probably safer for the pregnant mare and its fetus providing ‘stress’ is avoided. In these circumstances, the author uses (‘off-label’) 2 doses of clenbuterol (Ventipulmin™) at 800 ng/kg bwt injected slow i.v. before surgery and 6 h later.

Anaesthesia for caesarean section
When the fetus is alive, anaesthesia for caesarean operation must: 1) provide surgical conditions for operation; 2) ensure dam survival; 3) deliver a live, minimally depressed foal; 4) ensure a rapid recovery for both to allow nursing/suckling. Major physiological changes occur in the dam during pregnancy that influences anaesthesia. Whilst important in pregnant animals undergoing nonobstetrical operations, they are a maxima at term and so are of greatest relevance when anaesthetising mares for caesarean operation. Changes include an increased central nervous sensitivity to anaesthetics because of rising plasma progesterone levels. The cardiopulmonary effects of advancing pregnancy are of major concern and include: a physiological anaemia despite an increased effective circulating blood volume (ECBV) and erythrocyte mass; relative hypoalbuminaemia; increased cardiac output (reducing cardiovascular functional reserve); increased minute volume and a rostrally displaced diaphragm (and reduction of FRC). The later aggravate the tendency of anaesthetised horses to hypercapnia and hypoxaemia. A further problem is supine hypotensive syndrome, in which the gravid uterus compresses the caudal vena cava and the abdominal aorta in the dorsally recumbent mare and which may aggravate the adverse cardiovascular effects of anaesthetics.

Fetal vitality relies on adequate uterine blood flow (UBF) which depends in large part on arterial blood pressure, but is inversely proportional to uterine vascular resistance (UVR). Any factor decreasing UBF or increasing UVR will restrict blood supply to the fetus, causing hypoxia and acidosis. Factors increasing UVR include sympathomimetic drugs, e.g. ephinephrine, phenylephrine, and uterine contractants, e.g. α2 agonists, oxytocin. All drugs crossing the maternal blood brain barrier to produce sedation or anaesthesia, will inevitably cross the placenta and enter the fetus. However, fetal brain levels will generally be lower than that in the dam’s brain for several reasons. Weak basic drugs (opioids, phenothiazines, butyrophenones and local anaesthetics) become ‘ion trapped’ in the fetus. Providing the dam is not overdosed, anaesthetics will not unduly affect the near-term fetus unless it becomes disconnected through premature placental separation, caesarean operation or vaginal delivery. When this occurs the neonate must eliminate any plasma drug present. High fetal plasma levels of injectable drug will exert prolonged (not necessarily more profound) effects because the fetal liver and kidney may be functionally immature. Volatile agents will be eliminated providing the foal breathes.

Because anaesthesia in mares for caesarean operation carries such risk, there are advantages to using familiar techniques rather than unfamiliar, theoretically more appropriate methods. Short-, rather than long-acting drugs should be chosen with preference given to those with antagonists. Volatile agents confer major advantages; they can be eliminated by either spontaneous or controlled ventilation. Guafenesin is cumulative and long-acting and should probably be avoided. The reduced FRC and diaphragmatic splinting associated with late pregnancy means that inspired breath should be enriched with O2 and, if feasible, the lungs be periodically inflated.
Foal anaesthesia

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There is minimal published research regarding foal anaesthesia and pain management, therefore anaesthetic and analgesic drug dosages are often extrapolated from those published for adults. Foals older than 6 months of age can be treated like adults in regards to anaesthetic protocols. Unhealthy foals have physiological characteristics similar to a neonate and can be treated as such when determining sedative and anaesthetic protocols. Neonates are more sensitive to anaesthetics due to increased permeability of the blood brain barrier, an immature hepatic and sympathetic nervous system and a lower percentage of body fat to assist in redistribution of anaesthetic (Dunlop 1994).

Drugs that require significant hepatic metabolism like opioids, ketamine, benzodiazepines, lidocaine and α2 agonists should be used with discretion in neonates and unhealthy foals (Norman et al. 1997).

Complications to expect associated with anaesthetics in neonates and foals are vasodilation, hypothermia, hypoxaemia, hypercapnia and dependent lung atelectasis. Oxygen supplementation by oral intubation or nasal insufflation is recommended during procedures requiring prolonged recumbency. Sterile ophthalmic lubrication is essential to prevent corneal abrasions in sedate and anaesthetised foals. Additionally, the mare should remain with the foal during sedation and until complete induction when a procedure requires general anaesthesia. Removal of the mare during sedation or induction will produce excitement in both the foal and mare. The mare can be sedated with a combination of 150 mg acepromazine and 150 mg xylazine or an equivalent amount of romifidine or detomidine.

Alpha-2 adrenergic agonists, benzodiazepines and butorphanol are common choices for sedation in foals. These drugs can be administered alone or in combination and given i.v. or i.m. Foals less than one week of age will lie down when they feel tired or sleepy. Therefore, small amounts of sedatives will produce recumbency allowing for easy handling for noninvasive procedures. In a 30–40 kg neonate, a dose of 2 mg (range 2–5 mg) of butorphanol with 2.5 (range 2.5–5 mg) midazolam or diazepam administered i.v. will result in recumbency that lasts 15–30 min. By the addition of 100–150 mg ketamine i.v., a more invasive procedure can be performed like a joint flush or urinary catheter placement. Healthy foals older than 2 weeks might require the addition of an α2 agonist such as xylazine (30–80 mg i.v.) alone or combined with butorphanol, followed by 150–200 mg ketamine i.v. alone or combined with a benzodiazepine. Older foals (>1 week of age) will typically not become recumbent when sedated; therefore, these foals may need to be placed in lateral recumbency after administration of ketamine/diazepam.

For longer surgical procedures performed under general anaesthesia, a thorough physical examination and blood work (minimum: packed cell volume, total protein, white blood cell count and fibrinogen) should be included in the preanaesthetic work-up (Behr et al. 1981; Lakritz et al. 1992; Perkins et al. 1998). Pulse oximetry, capnography, arterial blood pressure and arterial blood gases are recommended monitors to determine oxygenation and quality of ventilation. Assisting ventilation at 1–2 breaths/min aids in opening atelectic alveoli and preventing hypercapnia. Maintenance fluids should be administered at a rate of 10–15 ml/kg bw/h.

The minimum alveolar concentration (MAC) of isoflurane in neonates is lower than adults; 0.84% vs. 1.3–1.6% for adults (Dunlop et al. 1989). Inhalant anaesthetic can be initiated at 2% isoflurane or 3% sevoflurane and then decreased to 1.5 and 2.5% respectively within 5 min of initiation. Anaesthetic concentration should be determined by clinic signs indicating depth. Blood pressure is helpful in determining depth of anaesthesia in foals but vasodilation can occur rapidly despite the fact that a surgical plane of anaesthesia has not been achieved. Mean arterial blood pressure should be maintained above 55 mmHg in young foals although normal mean blood pressure is typically lower in neonates up to one week of age (47–50 mmHg). Older foals should be treated as adults regarding blood pressure, with a goal of the mean arterial pressure above 70 mmHg. Normal heart rate in neonates is between 70–90 beats/min and can range between 40–60 beats/min in older foals (Rossdale 1970).

Recovery should be in a warm environment, often in the stall with the dam for neonates or in a recovery stall for older foals. It is helpful to have a blanket to cover the foal while it recovers. Warm blown air or circulating hot water blankets are ideal to warm the foal.

References and further reading


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Equine synovial fluid: synoviocentesis and analysis

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The most common reason for analysing synovial fluid in the horse is for suspected synovial contamination and infection.

Synoviocentesis
For accurate interpretation, a synovial fluid sample without iatrogenic haemorrhage or contamination is necessary. A number of techniques should be used to minimise these risks. The area should be clipped and aseptically prepared before aspiration. The patient should be adequately restrained (appropriate bit/sedation). Minimising patient movement is important and placement of a subcutaneous bleb of local anaesthetic at the proposed site of aspiration is recommended. The site selected for aspiration should be remote from any traumatic wounds/punctures and, when possible, areas of soft tissue swelling/infection. This reduces the risk of blood contamination and inoculation of the synovial cavity from periarthritic sites of infection. Knowledge of sites for joint injection, including both dorsal and palmar/plantar pouches is essential. Use of a (relatively) large bore needle (19 gauge) minimises needle blockage by fibrin or congested synovium. After needle insertion, if fluid flows freely this should be caught before any attempt at aspiration is made. If suction is required, this should be applied gently with a 5 ml syringe. Aspirated fluid should be collected into an EDTA blood collection tube for cytology and total protein determination and into an enrichment tube (biphasic blood culture medium) or lysing tube for culture and sensitivity. If a sample cannot be obtained (e.g. because of a draining wound), a wash sample (obtained following injection of sterile physiological fluid) may provide some information (i.e. white cell differential). Dilution of the synovial fluid can subsequently be estimated by determination of serum and sample urea (Gough et al. 2002), although in practice this is infrequently performed.

Normal synovial fluid
Normal synovial fluid should be clear, straw yellow coloured and viscous. Normal parameters are; total nucleated cell count <1 x 10⁹/l; white cell differential <10% neutrophils; total protein <20 g/l.

Contaminated and infected synovial fluid
Diagnosis of synovial contamination and/or infection on the basis of synovial fluid analysis alone is not straightforward and results should always be interpreted in light of clinical and historical findings. No one parameter measured can provide an entirely accurate diagnosis and instead interpretation should combine visual assessment, total protein and nucleated cell count and differential.

Visual assessment
Synovial fluid from infected synovial cavities is frequently turbid, and may be flocculent. Colour ranges from pale yellow, to orange or red. Sanguineous fluid is not unusual. Visual assessment is extremely useful and frequently accurate (Wright et al. 2003). Viscosity is usually reduced.

Total protein
Total protein can easily be measured on a hand held refractometer. Levels become elevated early (<24 h) in the pathogenesis (Tulamo et al. 1989) and frequently exceed 40 g/l (a level rarely reached with noninfected causes of synovitis). However, levels vary and may be less in acutely contaminated cavities, with ranges reported from 22–98 g/l (Schneider et al. 1992; Frees et al. 2002; Wright et al. 2003).

Nucleated cell count and cytology
Nucleated cell count can be measured by an automated analyser, or alternatively estimated with reasonable accuracy from microscopic examination of a smear. Smears can be made directly from synovial fluid, air dried and rapidly stained with a Romanowsky stain (e.g. Diff Quik). Total nucleated cell count rises early following microbial contamination (Tulamo et al. 1989) and typically exceeds 30 x 10⁹ cells/l (Wright et al. 2003). Marked variation, however, has been reported from 1.1–380 x 10⁹ cells/l (LaPointe et al. 1992; Schneider et al. 1992; Frees et al. 2002; Wright et al. 2003). In cases of established infection it has been postulated that white cells may become sequestered into deposits of pannus within the infected cavity (Ian Wright, personal communication). Cytological examination of synovial fluid from contaminated and infected synovial cavities typically identifies a neutrophil differential in excess of 80% (Schneider et al. 1992; Wright et al. 2003). Degenerative changes in neutrophil morphology are uncommon. Identification of microorganisms also is uncommon, although positive identification on a gram stain provides an early guide to antimicrobial selection.

Haemorrhagic fluid samples
Iatrogenic blood contamination at the time of sampling can often be differentiated as the sample is aspirated, with blood occurring in streaks within the synovial fluid. Infected synovial fluid samples are often sanguineous, but the degree of haemorrhage within the sample usually does not significantly hamper interpretation. Differentiation of haemarthrosis from infection, however, may be difficult. Nucleated cell count and total protein are significantly elevated from normal synovial fluid. In addition, the nucleated cell differential may have a high neutrophil percentage. Comparison of the synovial fluid nucleated cell count and differential with peripheral blood can be useful and similar values suggest an absence of infection.

Acute nonseptic inflammation
One of the most difficult conditions to differentiate from synovial
infection is post medication ‘flare’. Clinical signs are similar (severe lameness, joint distension, acute local inflammation). Flare may occur following injection of many substances, including local anaesthetics, HA, corticosteroids and PSGAGs. Clinicopathological values can be similar to values typical for synovial infection. There is no easy means of differentiation although, in the author’s experience, nucleated cell counts are often lower, but total protein high with flare. Early onset of clinical signs (<12 h) is suggestive of flare and, in the author’s experience, cases usually respond well to a single dose of NSAIDs. Clinical signs thereafter gradually resolve over 48–72 h.

Identification of synovial infection following injection of corticosteroids can also be difficult, due to suppression of the typical clinical signs of infection, synovial fluid nucleated cell count and total protein (Tulamo et al. 1989). Clinical signs may be suppressed to varying degrees for days or longer. Careful consideration of the clinical history, synovial fluid analysis and initial injury are required to best assess the presence or absence of infection.

Acute nonseptic inflammation also can occur in response to injury resulting in devitalisation of intra-synovial tendon and/or ligaments. Although uncommon, the author has seen cases with white cell counts in excess of 50 x 10^9/l, with >90% neutrophils. Differentiation from synovial infection is difficult, although clinical signs often are not entirely consistent (e.g. lesser degrees of lameness).

Synovial fluid culture

Bacterial culture is the gold standard means of diagnosing synovial infection and, in addition, identifies the causative organism and allows sensitivity testing. However, there is a delay (usually 48 h) from sample submission to diagnosis and false negative cultures are common (approximately 50% when enrichment media are not used and 25% when they are) (Pille et al. 2007). Due to the urgency of the condition, treatment therefore is instituted before the results of culture are available. A degree of caution is also required in interpretation - synovial infection most commonly occurs secondary to wounds and multiple bacteria are usually involved (but may not be identified). In addition, in vitro sensitivity does not always accurately reflect in vivo sensitivity.

PCR for identification of bacterial 16s rRNA is an alternative method for positively identifying bacteria in the synovial fluid and has a high sensitivity (approximately 90%) (Pille et al. 2007). This also avoids the delay with culture, with results in <24 h. Although species identification can be performed, standard culture techniques are still required for sensitivity testing. Currently, this method of bacterial identification is limited commercially.

References


Peritoneal fluid capture and analysis

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Peritoneal fluid analysis is a useful and important diagnostic tool. There are numerous indications for peritoneal fluid analysis and it is a procedure that can be safely and easily performed in the field.

Basic pathophysiology

The peritoneum is a single layer of squamous mesothelial cells lining the peritoneal cavity and abdominal viscera. Peritoneal fluid is constantly being produced and absorbed. In the normal situation, the volume of free fluid in the abdomen is low. Inflammatory stimulation results in release of histamine and serotonin from peritoneal mast cells and macrophages resulting in vasodilation and increased vascular permeability. The inflammatory cascade results in plasma transudation into the peritoneum, neutrophil chemotaxis, fibrin formation and continued vasodilatation. Within hours, an influx of fluid, protein and neutrophils into the peritoneum occurs. Factors resulting in peritoneal inflammation include infectious (bacteria, viral, fungal, parasitic) and noninfectious causes (traumatic, chemical and neoplastic).

Noninflammatory GI compromise also results in changes to peritoneal fluid. Visceral obstruction or torsion leads to vascular congestion which results in increased endothelial permeability, protein transudation and red and white blood cell diapedesis. If bowel wall ischaemia occurs, an exudative process develops and large quantities of protein and white blood cells move into the peritoneal cavity. As the mucosal barrier further breaks down, bacteria translocate across the intestinal wall and appear in peritoneal fluid.

Performing abdominocentesis

Capturing peritoneal fluid is a relatively low risk procedure and can be of great diagnostic benefit but there are risks involved that must be considered and minimised. If ultrasound is available, it is useful to identify fluid pockets before selecting your site. However, in the field abdominocentesis is often performed ‘blind’. The preferred location is 5–10 cm caudal to the xyphoid just to the right of midline. Abdominocentesis can be performed using a needle, or using a sterile cannula. The choice of instrument will depend on the size and body type of the patient and clinical preference.

Prior to performing abdominocentesis ensure the patient is adequately restrained and sedated if needed. Aseptically prepare an area ~10 x 10 cm at the selected site. If performing needle abdominocentesis, an 18 gauge 1.5” (3.8 cm) sterile needle is used. The needle is advanced through the skin and into the body wall in a controlled motion. The needle should then be advanced slowly, carefully detecting when the peritoneal cavity is entered and, if a change in resistance is met, that may indicate the needle is adjacent to viscera. If fluid drains from the needle, the necessary samples should be collected and the needle removed. If fluid is not obtained, collection from alternative sites within the sterile area can be attempted. In some cases, however, fluid will not be obtained and a decision must be made whether to stop collection attempts or try an alternative method.

If a cannula is being used to perform abdominocentesis the skin incision should be made small enough to ease cannula placement. The cannula is advanced through the body wall using firm, steady pressure. A distinct change in resistance can be felt when the body wall is penetrated. At this point, the cannula should be advanced slowly and carefully until a fluid pocket is reached. Once samples are collected, remove the cannula in a single controlled movement.

Abdominocentesis in foals should be performed with care. There is an increased risk of complication in foals and in general, ultrasound guidance is indicated. Smaller gauge needles should be used and use of a cannula is contraindicated in the majority of cases.

Complications

No fluid obtained

In normal horses, peritoneal fluid volume is low, making collection without ultrasound guidance relatively difficult. In addition, in animals with thick body walls, a needle or cannula may be too short to penetrate the body wall. In these cases a spinal needle may be of use to allow deeper penetration. Ultrasound guidance is useful in such cases to measure body wall thickness and ensure safe use of a longer needle.

Enterocentesis

Puncturing the viscera during abdominocentesis must be avoided at all costs. The risk of enterocentesis is increased when viscera are distended or impacted. In cases where there is known impaction or severe distension, the risks and benefits of abdominocentesis must be carefully considered and ultrasound guidance used if possible. If enterocentesis does occur, the needle/cannula should be immediately removed. Enterocentesis with a needle in adult horses generally results in minimal visceral trauma and further complications are unlikely. Enterocentesis when using a cannula can lead to more significant complications and the horse must be monitored closely for clinical signs of developing peritonitis. In foals, complications post enterocentesis are more common and foals suffering this complication should be monitored carefully for any evidence of peritonitis.

Infection at abdominocentesis site

This is extremely rare and can be avoided using good aseptic technique.

Puncture of the spleen

Splenic puncture results in dark coloured blood being identified in the needle/cannula. If this occurs the instrument should be immediately removed and a different site selected for abdominocentesis. In general, there are few complications associated with splenic puncture, but care must be taken in animals with clotting abnormalities.

Analysis

Four basic types of analysis can be performed on peritoneal fluid. The presentation of the case and the differential diagnosis list will determine which are most appropriate. In general, abdominocentesis supports a diagnosis but is rarely definitive.
White blood cell count and total protein concentration

Normal range: White blood cell count: ≤5000 cells/µl
Total protein: ≤2.5 g/dl (≤1.5 g/dl in majority of normal horses)

Inflammation results in an increase in both total protein and white blood cell count. Increased protein concentration is a sensitive indicator of inflammation. Total protein increases due to increased capillary permeability following vascular compromise and as a result of peritoneal inflammation, visceral necrosis and blood contamination.

Cytology

Basic cytological evaluation can be invaluable in analysing peritoneal fluid. In normal peritoneal fluid, 24–60% of peritoneal white blood cells are neutrophils. Neutrophils should be nontoxic and nondegenerate and no bacteria should be seen. An increase in neutrophils or neutrophils showing toxic or degenerate changes is an important indication of an ongoing inflammatory process.

Biochemistry

Several additional biochemistry tests can be performed on peritoneal fluid. The most useful additional tests are glucose concentration, lactate, fibrinogen and creatinine.

NOTES
Tracheal wash and bronchoalveolar lavage: sampling technique and fluid interpretation

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Introduction
Once respiratory disease is identified it is important to determine the cause, but many of the clinical signs of respiratory disease are common to multiple causes. Examining the cytological characteristics of the respiratory secretions can provide both an aetiology and, with repeated sampling, an indication of treatment response.

Tracheal aspirates
Most horses with pulmonary disease, accumulate excess respiratory secretion in the tracheal pool, approximately 15 cm proximal to the carina. There are 2 methods for collecting tracheal aspirates. Percutaneous transtracheal aspiration offers the benefit of bypassing the upper respiratory tract, almost eliminating the risk of sample contamination by commensal microflora of the nasopharynx. Transtracheal aspiration is performed in the mid trachea, where the tracheal rings are palpable ventrally. The area is clipped, disinfected and then 2 ml of local anaesthetic is injected subcutaneously. Next a large bore (14 to 10 gauge) catheter is passed between 2 tracheal rings into the lumen of the trachea, the stylette removed and narrow sterile tubing passed down into the lumen. Twenty to 50 ml of sterile saline is then infused into the trachea and aspirated from the tracheal pool.

Transendoscopic tracheal aspiration has largely replaced percutaneous aspirates because it is less invasive and requires no sedation or hair clipping. Also reports suggest that the quantity of endoscopically visible tracheal mucus is more closely correlated with poor performance than neutrophil percentages. The endoscope must be disinfected and a sterile polyethylene catheter is passed through the biopsy channel once the endoscope has reached the mid-trachea. Bacterial culture of transendoscopic aspirates has been criticised due to possible contamination from the nasopharynx. However, studies have shown contamination is less problematic than previously thought. Using a protected double lumen catheter or sterile agar plug can further reduce the risk of contamination. The ease and reliability of transendoscopic sampling outweighs the disadvantage of possible bacterial contamination.

Transient contaminants may be present in normal tracheal secretions. Therefore, culture results must be viewed with respect to the presence of intracellular bacteria and large numbers of bacteria in Gram stains. Semi-quantitative bacteriological techniques can be used. Normal secretions usually contain low numbers (<1000 colony forming units/ml) of mixed bacteria. Secretions from horses with bacterial infections usually contain larger numbers (>1,000,000 colony forming units/ml) of usually one bacterial species.

Bronchoalveolar lavage
Bronchoalveolar lavage (BAL) gives a more accurate representation of lung pathology than tracheal aspiration, except when pathology is localised to the cranioventral lung fields. BAL is invaluable in the investigation of pulmonary diseases, particularly recurrent airway obstruction and exercise-induced pulmonary haemorrhage. The volume of saline reported for BAL sampling ranges from 60–500 ml. While some research studies suggest that differential cell counts may be biased by small volume lavages, the published results do not appear significantly different between most studies. Clinically, 60–180 ml of saline is easier to handle in the field situation.

BAL is performed using a >2 m endoscope or a BAL catheter. The advantages of transendoscopic sampling are visualisation of the sample site and instillation of the local anaesthetic (20 ml) into the carina and major branches of the bronchi to reduce coughing. The advantages of the BAL catheter are that it is considerably cheaper and that the catheter procedure is faster and often requires no sedation or local anaesthesia.

Processing BAL and tracheal aspirate fluid samples
Following tracheal aspiration or BAL, the sample fluid should be examined for colour and the presence of mucus. Normal fluid should appear clear or mildly turbid. For BAL samples, a layer of foamy surfactant indicates that the alveoli have been sampled.

Samples should be processed within 8 h to minimise cellular deterioration and bacterial overgrowth. Fixation of samples using an equal volume of 40% ethanol eliminates bacterial overgrowth, but results in poor cellular morphology. Under field conditions it is best to prepare smears as soon as possible after sampling. Dried slides can then be sent to a laboratory.

The reference range of ‘normal’ nucleated cell counts is 300–800 cells/µl. Cytospin preparations are generally best for dilute samples, since many cells are concentrated into one area of the microscope slide, making cell counting easier. Alternatively, 5–10 ml of sample can be centrifuged, the supernatant poured off and the cell pellet smeared. Slides can be stained using Diff-Quick, Gram stain, Toluidine Blue (mast cells) and Perl’s Prussian blue (hemosiderin).

Tracheal wash and BAL cytology
BAL samples of normal horses contain mostly macrophages (60%), lymphocytes (35%), few neutrophils (<5%), and very few mast cells, eosinophils and epithelial cells (<1% each). Tracheal aspirates are mostly, macrophages (40–60%), a smaller percentage of lymphocytes (10–20%), a larger percentage of epithelial cells (10–20%) and similar percentages of neutrophils (5–10%), mast cells and eosinophils (<1% each) as BAL samples.

Neutrophils
Horses with symptomatic recurrent airway obstruction always show a respiratory secretion neutrophilia. However, RAO horses in remission have normal respiratory cytology. Respiratory viruses can induce a transient pulmonary neutrophilia. Thus it may not be possible to differentiate acute viral airway disease from RAO using cytology alone. However, horses with chronic post viral airway disease usually have normal respiratory neutrophil numbers and so can be differentiated from cases of RAO. Respiratory secretions from horses with bacterial bronchopneumonia generally have increased numbers of neutrophils containing intracellular bacteria.

Eosinophils
Respiratory secretion eosinophilia is uncommon and usually attributed to Dictyocaulus arnfieldi. However, other allergic causes should be considered in horses with a good worming history.
Haemosiderophages and erythrocytes
Free erythrocytes may be identified in respiratory secretions collected within 3 days of significant pulmonary haemorrhage. These erythrocytes are phagocytosed by macrophages giving rise to haemosiderophages. Haemosiderin is easily recognised as brown or blue/black pigment granules. The clearance of haemosiderin from the lungs may take several months.

Further reading

NOTES

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Bone marrow sampling is a diagnostic technique that can be of great clinical value when used in the right cases. However, it is not a routine procedure and should only be carried out when the risks and benefits have been properly considered.

**Basic pathophysiology**

Post natally, the bone marrow becomes the major site of haematopoiesis. In young foals, almost all marrow is haematopoietically active while in adults, red marrow is found primarily in the epiphyses of long bones and in flat bones such as the skull, vertebrae, sternum, ribs and pelvis.

Bone marrow contains the progenitors of red and white blood cells in varying states of maturation. All blood cell progenitors stem from pluripotent stem cells. The progenitors develop into cells from the myeloid and lymphoid lineages. The myeloid lineage gives rise to megakaryocytes, erythrocytes, phagocytic cells and eosinophils while the lymphoid lineage gives rise to B and T cells.

**Circulatory half-life of equine cells:**

- Erythrocytes: 155 days
- Platelets: 7–10 days
- Neutrophils: ~10 h

**Performing bone marrow sampling**

It is important horses are adequately restrained during bone marrow sampling to maximise the chance of a good quality sample being obtained and minimise the risk of complications.

Theoretically, there are several sites you can use for bone marrow aspiration in the adult horse; sternum, rib, iliac crest. However, in reality, the sternum is the site of choice in adult horses. In foals, the iliac crest is the most commonly used site.

The decision whether to perform bone marrow aspiration or core biopsy depends on the reason for sampling. Aspiration often results in better preservation of cell morphology; however, it does not allow true assessment of marrow architecture or cellularity. In some cases performing both techniques will be necessary.

When performing a sternal bone marrow aspiration/biopsy, the sampling site is on the ventral midline, between the deep pectoral muscles, midway between the points of the elbows. The area is clipped and aseptically prepared and local anaesthetic infiltrated into the skin, muscle and periosteum. A small skin incision is then made to ease passage of the aspiration/biopsy instrument.

For bone marrow aspiration, a 3.5", 16 gauge spinal needle or a sternal-iliac aspiration needle can be used. The needle is advanced through the skin incision, perpendicularly to the sternum, until it makes contact with the ventral aspect of the sternum. Firm pressure is applied to the needle and it is advanced in a rotational movement through the cortex and into the bone marrow cavity. A change in resistance is often felt when the marrow cavity is entered. However, this change in resistance is not a consistent finding and care must always be taken to be aware of how far the needle has advanced.

When the needle is seated in the bone ~1–2 cm aspiration should be attempted. The needle stylet is removed and a sterile 10–20 ml syringe is used to create a negative pressure vacuum to dislodge bone marrow particles. Drops of sanguinous fluid should appear in the hub of the needle. As soon as blood is seen in the hub of the syringe suction should be discontinued, the syringe removed and the sample quickly processed. The first drop of blood tends to be the most cellular of the sample. If no sample is obtained, you can carefully advance slightly further (with the stylet in place) or try an alternative position within your aseptic area. When sampling is complete, remove the needle and apply pressure the incisional area to aid haemostasis.

If a core biopsy is being performed, a large gauge biopsy instrument, such as a Jamshidi needle, is used. The skin incision must be large enough to allow the instrument to pass easily to the sternum without skin drag. A twisting motion is used to drive the biopsy instrument through the outer cortex of the bone and into the bone marrow cavity. Once the biopsy instrument is seated in bone, the stylet is removed and the needle advance 1–2 cm further (if possible) using the same twisting motion. The biopsy instrument is then rotated and rocked to break off the biopsy core. Again, care must be taken to ensure intra-thoracic penetration does not occur. When the instrument is removed, a stylet is used to push the biopsy material out of the core. Ideally, 1–2 cm of red marrow will be obtained.

Bone marrow samples should be processed quickly to ensure the best chance of the sample providing useful diagnosis. Bone marrow aspirates clot quickly. To avoid this, syringes can be primed with 1–2 drops EDTA prior to aspiration. Once sample is collected in an EDTA primed syringe it can be transferred directly to glass slides. If syringes are not pre-primed, collected fluid is placed in a petri dish containing EDTA. Spicules of bone are then collected from the petri dish and placed on glass slides using a pipette. Slides are prepared for evaluation by gently smearing one slide with a second slide. You should aim to create about 10 slides to increase the chance of successful diagnosis. Core biopsies are rolled on a glass slide to create an impression smear and then placed in 10% neutral buffered formalin.

When any bone marrow sample if submitted for testing a peripheral blood sample and fresh blood smear should also be submitted to allow full analysis to be carried out.

**Complications**

- Nondiagnostic sample
- Intra-thoracic penetration
- Infection of the bone marrow aspiration site
- Haemorrhage

**Analysis**

Bone marrow analysis should be carried out by an experienced equine clinical pathologist. However, immediately post sampling, a slide should be stained with Wrights-Giemsa and assessed to determine if a diagnostic sample has been obtained. This allows a second sample to be obtained if needed.

The basic steps taken when assessing bone marrow cytologically are listed below. However, this is not a complete list and full bone marrow evaluation requires the expertise of a skilled equine clinical pathologist.

**Cytology**

- Low magnification assessment:
  - Evaluate cellular density of bone marrow particles
  - Evaluate iron stores within particles
  - Assess megakaryocyte numbers

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**Bone marrow sampling and evaluation**

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Bone marrow aspiration in the adult horse; sternum, rib, iliac crest.
High magnification assessment:
- Evaluate myeloid and erythroid cell lines
- Assess myeloid:erythroid ratio (0.5–1.5 regarded as normal range in horses)

- Evaluate cell morphology and cell maturation
- Determine if dysplastic cells or infectious organisms are present.
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Next Congress:

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The equine genetics programme - a study of musculoskeletal disease in the Thoroughbred

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Musculoskeletal injuries result in loss of horses from training and racing and are a significant cause of equine mortality. In the UK around 50% of racehorses experience lameness at some point during training, with up to 45% unable to race in the year they are injured (Wilsher et al. 2006; Dyson et al. 2008). The equine genetics programme at the Animal Health Trust has focused on 3 musculoskeletal conditions - fracture, recurrent exertional rhabdomyolysis (RER) and osteochondrosis dissecans (OCD). Fracture is a significant cause of horse mortality in the UK racecourse, fatal distal limb fracture has an annual prevalence (for flat and NH) of about 0.4% (Parkin et al. 2004). Recurrent exertional rhabdomyolysis (RER or ‘tying up’) has been identified as the third leading cause of lameness in Thoroughbreds (Jeffcott et al. 1982), with a prevalence in the UK of around 3% (McGowan et al. 2002). Osteochondrosis dissecans (OCD) is one of the most common developmental orthopaedic conditions in horses, with prevalence estimates varying between 10 and 32% dependent on the population and the site of OCD (Jeffcott et al. 1993; Pagan and Jackson 1996). There is evidence that some equine musculoskeletal conditions are heritable (Oki et al. 2005; van Grevenhof et al. 2009) and recent advances in the development of equine genomics tools (Wade et al. 2009) has facilitated rapid progress in unravelling the genetic basis of these conditions.

During the course of the equine genetics programme 1332 samples for 3 musculoskeletal conditions have been collated. Fracture cases (n = 280) were horses that sustained catastrophic distal limb fractures on UK racecourses, requiring euthanasia and were obtained from an archive of samples collected during a previous study (Parkin et al. 2004). The exact fracture site and type were identified by post mortem examination. Fracture controls (n = 263) were a mixture of uninjured horses originally selected from the same race as the case and uninjured horses sampled as part of a previous study. All fracture control horses were traced and verified as having no known history of fracture up to the time of the study. RER cases (n = 186) were horses in training in the UK that had shown clinical signs of RER on more than one occasion and had a blood creatine kinase (CK) level greater than 2000 iu/ml at the time of sampling. RER controls (n = 202) were from the same age group and undertaking a similar level of training as the RER cases, but had never suffered an obvious clinical RER episode and had a blood CK level of less than 500 iu/ml on the day of the case horse RER episode. OCD cases (n = 201) were horses that underwent arthroscopic OCD surgery in a US equine clinic. The condition was diagnosed radiographically and confirmed arthroscopically by the presence of an OCD flap or fragment associated with a defect in the femoropatellar, tarsocural or fetlock (metacarpophalangeal or metatarsophalangeal joints). OCD controls (n = 200) were any horse of the same age and from the same stud as the case horse, admitted to the same clinic for a reason other than OCD or associated developmental orthopaedic disease.

Genotyping was performed using the Illumina Equine SNP50 BeadChip, generating 43,451 genotypes (after quality control procedures) per individual at an average spacing of one marker or single nucleotide polymorphism (SNP) per 43.2 kb of DNA. Genome-wide association analysis identified 2 significant genomic regions associated with catastrophic racecourse fracture, 4 regions associated with RER and at least one associated with OCD. Further studies are aimed at refining the location of candidate genes within these regions and identifying putative causal mutations. The identification of the genes underlying susceptibility to musculoskeletal disease will lead to better understanding of the biology, which in turn may suggest potential therapeutic targets and better management strategies. Identification of genetic variants associated with the risk of musculoskeletal disease also suggests that DNA tests for genetic risk may become an option for these diseases. The accurate estimation of genetic risk for complex diseases is, however, likely to need larger data sets and the use of genomic selection approaches to provide a robust and reliable test (Goddard and Hayes 2009).

References
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Athletic performance is influenced by a complex interplay among the environment and a suite of genes, which contributes to systems-wide structure and function. While the phenotypic adaptations to elite athleticism in Thoroughbred horses are well described, the understanding of the molecular contributions to such exquisitely adapted exercise-related phenotypes is still in its infancy. In humans, genetic contributions to athletic performance phenotypes are well documented and more than 220 gene loci have been described (Bray et al. 2009). While it is likely that Thoroughbred racing performance is also influenced by a large number of genes, only 2 performance-associated sequence variants in exercise-relevant genes, MSTN (Hill et al. 2010a) and PDK4 (Hill et al. 2010b), have been reported for the horse. The availability of the horse genome sequence (Wade et al. 2009) and associated genomics-tools is now enabling research scientists to understand genetic contributions to complex traits in the horse. This information is already being used to improve selection, breeding and racing decisions in the Thoroughbred industry (www.equinome.com). Furthermore, the prospective identification of genetic potential may provide opportunities to individually design conditioning programmes to reduce injury risk. These opportunities will be realised through an understanding of the relationships between measureable physiological parameters (Fonseca et al. 2010) and genetic variants.

References and further reading

NOTES
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14.15–14.30
Genetics of performance
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Genetics of equine myopathies
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Exertional myopathies
We currently recognise 2 common forms of exercise-related myopathy in horses with underlying genetic causes. These include a condition examined extensively in a group of Thoroughbreds in the USA that has been termed ‘recurrent exertional rhabdomyolysis’ (RER) (Lentz et al. 1999) and another condition, termed ‘polysaccharide storage myopathy’ (PSSM or EPSM) (Valberg et al. 1996; Valentine et al. 2000). These conditions have clinical and clinicopathological similarities and are managed similarly, though they also have key differences and breed susceptibilities (Valbert et al. 1999).

Recurrent exertional rhabdomyolysis
Estimates of the prevalence of exercise-associated rhabdomyolysis in Thoroughbreds suggests that 5–7% of Thoroughbreds worldwide are affected (MacLeay et al. 1999a; McGowan et al. 2002; Cole et al. 2004), although it remains unknown whether all these animals have the same disorder. Pedigree analysis of some lines of Thoroughbreds in the USA supports autosomal dominant inheritance of the trait (MacLeay et al. 1999b; Dranchak et al. 2005). An abnormality in muscle calcium regulation identified in some Thoroughbreds shares certain experimental similarities to a condition recognised in humans and other species, known as malignant hyperthermia (MH). In particular, muscle from horses with RER and other species with MH is hypersensitive to agents (such as caffeine and halothane) that stimulate release of calcium from the muscle calcium store (sarcoplasmic reticulum) through a calcium release channel known as the ryanodine receptor (RYR1) (Lentz et al. 1999, 2002; Bendahan et al. 2004). However, though MH has been reported in some horses following halothane anaesthesia, and indeed, though an RYR1 receptor (RYR1) (Lentz et al. 2004) Exclusion of linkage of the RYR1, CACNA1S, and ATP2A1 genes to recurrent exertional rhabdomyolysis in Thoroughbreds. Am. J. Vet. Res. 67, 1395-1400.


Other myopathies
Glycogen branching enzyme deficiency is another myopathy associated with abnormal accumulation of polysaccharide within muscle, but unlike PSSM, the polysaccharide also accumulates in other tissues (Valberg et al. 2001). This fatal disease is the equine equivalent of human glycogen storage disease type IV (Anderson’s disease) and has been reported as an autosomal recessive trait in Quarter Horse aborted fetuses and neonates in the USA (Ward et al. 2004). It is caused by a mutation in the equine GBE1 gene (Ward et al. 2004).

References


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First recognised in NW England in 1995, this fatal disease of Fell and Dales pony foals has become a major welfare issue for these breeds. FIS is characterised by weakness and poor growth of foals after 2–6 weeks of age; this is concurrent with anaemia of increasing severity and multiple opportunistic infections. FIS is 100% fatal with no treatments being effective. The profound anaemia is nonregenerative and PCVs as low as 3% have been detected. The wide range of infections are associated with reduced lymphocyte numbers in the circulation and in the thymus and lymph nodes.

Immunological analysis showed that circulating PMN and T lymphocytes were normal in number; also, PMN showed no deficiencies in phagocytic ability. The lymphopenia was shown to be due to an almost complete lack of circulating B lymphocytes associated with a corresponding lack of circulating immunoglobulins. There were also reduced numbers of B lymphocytes in spleen and lymph nodes.

Since identification, 10–20% of Fell pony foals born each year have had FIS; only 2 Dales foals with the syndrome have been reported. Stud books have clearly indicated that the disease has an autosomal recessive mode of inheritance and explained why carriers (heterozygotes) of the FIS gene were completely normal clinically compared to the homozygotes which all died within a few weeks of birth. Hence, there was a clear and certain need to identify carrier ponies to prevent further FIS foals being born and to reduce FIS-gene spread in the Fell and Dales ponies (and possibly also in other equine populations). To achieve these goals, it would be necessary to identify the FIS genetic lesion(s), develop a diagnostic test and screen the Fell and Dales pony populations. Using the comprehensive archive of blood and DNA samples from previous studies, we were able to develop a strategy to identify the genetic lesion responsible for FIS in Fell and Dales pony foals.

Initial work used a panel of 286 equine microsatellites to identify which chromosome carried the causal lesion. The results showed chromosome 26 as the most likely candidate and identified a large suspect region on this chromosome.

The next step was to use the available SNP chips developed for horses (Illumina); each contained 54K known equine single nucleotide polymorphisms (SNPs). A case-control allelic association test (Genome Wide Association Study, GWAS) was performed and analysed by PLINK. The results conclusively confirmed the critical region previously identified, indicating a 154-fold likelihood of disease association compared to the rest of the genome, but did not identify a FIS-specific SNP. Previously, the microsatellite markers had indicated a small block of homozygosity in a region spanning 2.3 Mb; the GWAS analysis reduced this to 1.2 Mb.

The third step was to use next generation gene sequencing technology. Firstly, the candidate region was captured after the DNA samples were hybridised to a NimbleGen Sequence Capture array. This region, in FIS foals, carrier foals and normal foals, was then sequenced using Roche 454 GS FLX Titanium technology. Comparisons of DNA sequences quickly indicated 16 SNP variants which could be associated with FIS. However, only 1 SNP variant survived critical analysis and this SNP was homozygous in all FIS ponies, heterozygous in all FIS carriers and absent in all normal (noncarrier) ponies. This SNP is in an exonic region and results in an amino acid change.

We have been offering a diagnostic test for FIS foals and carriers since February 2010 and been giving advice on breeding strategies to 1) prevent FIS foals being produced and 2) reduce the numbers of FIS carriers in the pony populations. We are currently testing archive samples from other horse breeds as we know that extensive cross breeding may have provided opportunities for the FIS gene to ‘silently’ spread in other equine breeds.

Current estimates indicate 42–48% of Fell ponies and 10–18% of Dales ponies are carriers. Hence, animals will need to be tested for several years to come before strategic breeding programmes can reduce the carrier numbers in breeding animals to insignificant proportions.

Acknowledgement
This work was supported by the Horse Trust.

Further reading


It is recognised that increased movement of horses between Member States poses a risk of disease spread (Herholz et al. 2008). Every year around 80,000 horses are transported long distances across Europe for slaughter. The vast majority of these horses originate in Eastern Europe or Spain and are destined for slaughterhouses across Italy, including the islands of Sicily and Sardinia. Horses may pass through as many as 7 different Member States en route to slaughter. World Horse Welfare carries out regular field investigations into the trade; poor welfare, including health, is a consistent finding with dehydration, exhaustion, injury and disease being commonplace.

The potential for disease spread is clearly demonstrated by recent outbreaks of Equine Infectious Anaemia (EIA) in the UK, France, Belgium and Germany. The 2010 UK outbreak occurred in a group of low-value (nonslaughter) horses imported from Romania; subsequent investigations revealed infected Romanian horses at several premises within Belgium. Romania, where EIA is endemic, is one of the largest exporters of horses to Italy for slaughter. Although legislation exists to prevent EIA spreading outside the country, through compulsory Coggins’ testing of all horses destined for export from Romania, this safeguard has failed on a number of documented occasions. In 2006, 41% of horses that tested positive for the disease in Italy, another country where EIA is endemic, were imported animals (AHT 2007).

The following year, when compulsory Coggins’ testing of all sports horses was reintroduced in Italy, the number of new EIA outbreaks identified in the country increased 12-fold (OIE 2010). Furthermore, routine surveillance at Italian slaughterhouses continues to detect EIA positive horses amongst those originating in Romania (Defra 2010).

It is evident that transportation of horses has contributed to the movement of EIA within Europe; it is, therefore, reasonable to assume that a whole spectrum of infectious equine diseases could be spread in this way. Long-distance transportation of horses for slaughter is likely to significantly increase this risk, given the potential for direct contact, both with other horses and with bodily secretions including urine, faeces, mucus, saliva and blood, is extremely high. Interaction between slaughter horses and breeding or riding stock, also frequently housed at Assembly Centres, is not uncommon. Such interaction increases the likelihood of disease spread into the general population, both locally and more widely through intra-community trade. Horses from a number of these Assembly Centres have entered the UK on many occasions.

Potential for indirect transmission of disease through contaminated personnel and equipment is high; protective clothing and facilities for cleansing and disinfection are frequently lacking and, when present, are not used diligently.

With annual movement of tens of thousands of horses over hundreds, or thousands, of kilometres through more than a dozen Member States, the sheer scale of the trade in slaughter horses is sufficient to increase the likelihood of disease spread. When combined with limited biosecurity, existing ill-health, stress, fatigue, immunosuppression and poor transport conditions, onward transmission of disease would appear almost inevitable, jeopardising not only the health and welfare of individual animals but threatening the equine industry as a whole.

It is suggested that the long-distance transportation of horses across Europe for slaughter carries a real risk of the spread of both exotic diseases, such as EIA and serious endemic diseases, such as influenza and strangles. This risk could be considerably reduced by slaughterhouses destined for the food chain at a location situated as close as possible to the premises of origin and transporting their carcasses in accordance with international rules for the production and transport of meat for human consumption.

For the purposes of this abstract, ‘horses’ refers to all horses, ponies, donkeys, mules, hinneys and other equidae.

References


What is the destiny of horses that cannot be slaughtered in the United States?

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In 2005 the American Association of Equine Practitioners sponsored the Unwanted Horse Summit to focus attention on the problem of unwanted horses in the United States (US). As a result the Unwanted Horse Coalition was created under the auspices of the American Horse Council. In 2007 horse processing was curtailed by federal legislation in the US increasing the risk for a critical overpopulation of unwanted horses.

“Horses which are no longer wanted by their current owner because they are old, injured, sick, unmanageable, fail to meet owner’s expectations (e.g. performance, colour, breeding) or their owner can no longer afford them” are considered unwanted. The term has recently been associated with horse slaughter in the US because of the number of horses processed and marketed for human consumption in Europe. With the advent of public awareness of horse slaughter during the last decade, a political movement, led by animal activists and humane groups, successfully legislated closure of US slaughter facilities in 2007.

In 2006 104,899 horses were processed in the US with an additional 26,000 and 19,000 processed in Canada and Mexico, respectively. In 2007 the numbers shifted to 29,769 processed in the US (prior to plant closure) and 47,000 in Canada and 45,000 in Mexico. Subsequently in 2008 77,000 horses in Canada and 69,000 horses in Mexico were processed. The numbers show decline to 88,276 exported for slaughter in 2009. To date in 2010 24,589 horses have been exported to Mexico for slaughter, a number slightly higher than last year for the same time period.

Other than slaughter or elective euthanasia there are few alternatives to control the large population of unwanted horses in the US and this is particularly true of horses with medical or behaviour problems, which affect their original or alternative use. Some options exist including changing occupations, rescue/retirement/retraining facilities, adoption, donation to universities and donation to therapeutic riding programmes. None of these options has the capacity to care for all the unwanted horses if the current export for slaughter were to be curtailed.

The American Horse Council assessment found rescue/retirement/retraining facilities are maintaining 18,060 horses annually. Current occupancy of rescue/retirement facilities is at 81% with an average of 26 horses per facility and a total of 11,180 horses are turned away annually by each facility. The total cost to care for a horse at one of these facilities is estimated at $2300. It is estimated that another 2700 retirement facilities would be needed to manage the number of unwanted horses if US horses could not be exported for slaughter.

Even with the current outlet for horses by export to Canada and Mexico, reports of abandoned horses have increased in all parts of the US. This is in part due to the current economic recession, which decreased personal income normally used to care for horses. Currently municipal and county authorities with animal shelters or private rescue organisations manage horses that are neglected or abandoned. If the export outlet for slaughter is shut down, the excess horses will probably be managed in a similar way to the millions of unwanted dogs and cats in the US each year; horse adoption or euthanasia at the expense of the local county or city governments.

Recently several states have passed legislation allowing companies to operate horse processing plants in the United States, but depending on proposed national legislation on transporting horses for slaughter, any new facilities may only be able to accept horses within each individual state.

Wild horses in the US also pose an unwanted horse problem. These descendents of Spanish horses delivered to the America during exploration live on US rangeland and currently are overpopulated for the capacity of their environment. Though private owners adopt some of these horses each year, many are eventually moved to fenced rangeland and cared for by the US government. The public concern over the wild horses currently prevents population control of healthy horses by euthanasia or slaughter.

Solutions to manage the unwanted horses in the US include 1) increasing education about responsible ownership and breeding, 2) increasing the capacity of retirement/retraining facilities, 3) reopening of processing plants in the US or 4) increased resources for euthanasia and disposal. Though mentioned as a way to manage unwanted horses, euthanasia and disposal has an estimated cost of $300–$1200 per horse, which prevents some owners from utilising this option.

Further reading
Mexico, Canada increase horse slaughter production, American Veterinary Medical Association News, http://www.avma.org/onews/jama/nov10/100515o.as
Effect of different surfaces on injuries in dressage horses

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In dressage horses, lameness has been identified as the most prevalent health problem with 24% of horses in a questionnaire-based study having been lame in the previous 2 years, resulting in being out of competition for a median of 5 months within that 2 year period. It is therefore important to understand what factors could predispose to these injuries. Compared to horses doing other sports, dressage horses have a high risk of hindlimb suspensory ligament injury. Using a questionnaire-based study of dressage horses in the UK, the most frequent sites of injury in dressage horses were the foot, the suspensory ligament and the tarsus. Recent work has indicated that there are various risk factors for injury in dressage horses. These include individual horse features, and training and management factors. One of the areas that has been shown to be a risk factor for injury is training surface.

Artificial surfaces are increasingly used for training dressage horses. Research into the surfaces used by human athletes has shown that injury risk and performance can be affected by training and competition surfaces. Physiological adaptation to a surface can reduce injury risk in man, and this is supported by work in dressage horses where a sand surface was associated with higher risk of lameness than other surfaces, but increased frequency of training on sand relatively reduced the risk of lameness. However, use of a single surface for training can be detrimental if peak performance is required on a different surface. Use of multiple surfaces and training types for proprioceptive conditioning can be beneficial. In dressage horses, risk of lameness is reduced by turnout, hacking, lunging and jumping which could be related to improved proprioceptive conditioning and core muscle strength.

In dressage horses, training surface characteristics that increased the likelihood of lameness in dressage horses are being patchy or uneven in normal conditions, changing to deeper or boggy in wet conditions, or to patchy or firmer in hot/dry conditions. In contrast, surfaces that remained uniform in normal and hot/dry conditions were associated with a reduced likelihood of lameness. Problems of horses tripping, slipping and/or losing balance were associated with an increased likelihood of lameness.

Various surface and arena features are associated with properties that increase risk of lameness. These include surface type, base type, arena use, ownership and size. Overall, livery yards or nonprivately owned arenas and arenas with more horses using them are more likely to be associated with problems, and are at higher risk of lameness than privately owned arenas. Smaller arenas tend to become patchy and uneven, change with weather conditions and increase the risk of tripping of losing balance. Wax coated or sand/rubber surfaces tend to stay more uniform under different weather conditions while sand has a high risk of becoming uneven, patchy, changing with weather conditions or leading to horses tripping and losing balance. Woodchip as a surface carries by far the highest risk of horses slipping, is more likely to be uneven and patchy than wax coated or sand/rubber, changes with weather conditions and is also associated with losing balance.

Arena surface components can influence the properties associated with lameness. In general, fine sand is better than coarse sand for preventing tripping. Large chunks or strips of rubber are more likely to be associated with tripping than small rubber chunks, while rubber on top of the surface increases the likelihood of the surface remaining uniform.

Arena design can affect the properties that increase lameness risk. Absence of arena base is associated with various detrimental arena properties related to lameness, while arena base type can also influence problems. A limestone base is preferred while a crushed concrete base is associated with slipping or tripping. Smaller arenas increase risk of negative surface properties. Maintenance of the arena surface is also important in relation to lameness. Frequency of management (levelling) of the surface and number of horses using the arena can influence the properties predisposing to lameness, with increased frequency of levelling and less horses being relatively protective.

Further reading
Preparing horses, and in particular preparing horses to compete at high levels requires a systematic approach to training that both improves both horse and rider. Selecting appropriate training methods must achieve the effect that the rider wishes to have, but must never be secondary to the horse’s welfare.

Over time many equestrian regulatory bodies have developed codes of practice with regard to the welfare of the horse. There are also statutory obligations to animal welfare put in place by the state. The FEI Welfare Code states that the welfare of the horse must never be secondary to commercial and competitive pressures. However much like human athletes at different levels, horses can cope with certain techniques and exercises depending where they are in their careers and levels of fitness. For example young horses will not tolerate many types of training that are easily used in more mature and fitter horses.

This presentation explores the challenges of trying to regulate this complex area.

NOTES
Proceedings of the 49th British Equine Veterinary Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

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Hoof mapping - locating internal anatomy structures using external references

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Historically, many farriers and hoof care educators have made reference to a ‘Centre Point’ on the bottom of a horse’s foot that correlates to either the distal phalanx or the centre of articulation of the distal interphalangeal joint, or both. There have been several formulas for locating or describing this centre reference point. The majority have been based around the use of the frog apex as a starting point for finding the centre of the foot. For the most part the frog apex has been a fairly reliable guide, as it does not appear to easily lose its relationship to the internal anatomy. However, as the inclusion of a frog apex marker on radiographs has become more popular over the last decade or so, many irregularities have been noted as to the position of the marker with respect to the dorsal, distal border of the distal phalanx. It can be assumed that in some cases the TRUE apex of the frog may not have been adequately indentified prior to inserting the radiograph marker, which would account for some of the irregularities. However, even in cases where a TRUE frog apex was well established, some relational disparity is still noted. Therefore, the use of the frog apex as a sole guide to establishing the location of a centre point of the foot appears to be less than reliable than previously thought.

There have been several methods and measurements used over the last few hundred years for finding the centre point of the foot from the frog apex. The most common and currently most widely used methods employ a measurement of 3/4” to 1” (19–26 mm) back or caudal to the frog apex as the centre of the foot. Again, through a sampling of marked radiographs taken over the last 10–15 years, the measurement of 3/4” (19 mm) caudal to the frog apex frequently falls short of the centre of articulation of the DIP joint. Many times using the distance of 3/4” (19 mm) fails to even reach the confines of the DIP joint. Therefore, when the frog apex is used as the starting point for determining the centre of the foot, the commonly used measure of 3/4” (19 mm) appears to be insufficient in most cases.

In 2006, the Equine Lameness Prevention Organization began offering hoof care education and certifications. In further developing the trimming and shoeing protocol promoted by the organization, the board of directors and advisors began looking for multiple external references to the internal structures. They felt that this would improve the consistency and success of the guidelines being taught. Over the first 2 years of the certification courses and dissections done during the courses, the E.L.P.O. further developed a Hoof Mapping protocol that seemed to offer better, more consistent results than anything previously used.

However, with more answers always come more questions and more scrutiny. In 2008, the Equine Lameness Prevention Organization put together a well designed scientific study to help answer some questions about a specific method of locating internal anatomy from external references. The goal is not to measure or establish any sort of correct or incorrect approach to hoof care. Instead, the goal was to help establish a baseline or starting point in which farriers and vets would be able to have confidence in where the anatomy is located within the hoof capsule when radiographs are not available. Additionally, through a reliable protocol for referencing the internal anatomy, future research projects could improve the control of variables in hoof balance, which have been largely in question in past studies.

The research protocol consists of ‘Mapping’ or locating the Widest Part of the Foot and the distal phalanx within the hoof capsule using the E.L.P.O. Hoof Mapping Protocol. From this Map, various markers are placed on the sole surface of the foot, as well as the dorsal hoof wall. Measurements are recorded and photographs of each foot are taken for reference. Radiographs are then taken of each foot using a standardised AAEP accepted protocol. Each radiograph is calibrated and measurements are taken using the Metron software. All data is recorded into a database so averages, comparison and results can be drawn upon.

There are currently 180 feet gathered over a 2 year period that are included in this study. Feet were mapped out and markers were placed by over 20 different farriers and the radiographs were taken by at least 7 different veterinarians. The results have shown that the E.L.P.O. Hoof Mapping Protocol can help located the dorsal, distal surface of the distal phalanx (tip of the distal phalanx) to within ± 1/8” (3 mm) on a given foot, regardless of size or conformation, at a 90% or better accuracy. Further results have shown that the same protocol places the Widest Part of the Foot in a very close proximity to the centre of articulation of the DIP Joint in most situations. However, the angle of the distal phalanx (meaning negative, flat or positive) plays a large role in the alignment of the WPOTF to the CoA of the DIP Joint based upon the fact that the distal end of the middle phalanx is positioned differently within the joint when the distal phalanx is at different angles. Nevertheless, the results of the E.L.P.O. research have given the industry a better way to accurately locate the distal phalanx within the hoof capsule when radiographs are not available. In turn, this should ultimately help farriers and vets alike improve their ability to recognise hoof capsule distortions before these distortions contribute to common pathology and lameness issues.

Notes
The Widest Part of the Foot Research data has not currently been published in a peer reviewed scientific publication. However, full details of the project can be found by contacting the Equine Lameness Prevention Organization (a Non-Profit Corporation).

Website: www.e-hoofcare.com
Saturday 11th September 2010

11.20–11.40
Medical treatment options in foot lameness

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No abstract submitted

NOTES
Radial pressure wave or extracorporeal shockwave therapy and foot pain: is there any evidence of efficacy?

Sue Dyson
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Extracorporeal shockwave therapy (ECSWT) and radial pressure wave therapy (RPWT) have been used in a variety of circumstances, but there is limited evidence of documented efficacy, especially related to conditions of the foot.

Sixteen horses with ‘navicular syndrome’ were treated using ECSWT using 1000 pulses through the frog and 1000 pulses from between the heel bulbs under general anaesthesia at 0.89 ml/mm (Bär et al. 2001). Video recordings from before and after treatment were analysed blindly. 56% of horses improved at least 1 lameness grade (AAEP grading scale of 0–5) (McCulre et al. 2004). Owners reported that 69% of the horses returned to the previous level of activity. There was no comparative control group. No horse underwent magnetic imaging (MRI) and therefore the precise cause(s) of pain and lameness were not clear. The degree and duration of lameness prior to treatment were poorly defined. In another study of horses with navicular syndrome, all 26 horses treated under general anaesthesia with 3000 pulses at 0.56 ml/mm (Bär et al. 2001) were free of lameness at 6 months (Bär et al. 2001). Once again, horses did not undergo MRI and the cause of pain was ill-defined.

The analgesic effect of ECSWT and RPWT have been assessed in 2 clinical studies. In horses with unilateral navicular syndrome and osteoarthritis of the distal interphalangeal (DIP) joint where analgesia was measured as a change in increase in peak vertical force after treatment, some analgesia from ECSWT was identified that peaked at 48 h after application (Dahlberg et al. 2006). In a similar study using horses with unilateral ‘navicular syndrome’ and RPWT, no analgesia was found (Brown et al. 2005). It is possible that the RPWs may not reach a sufficient depth to affect pain sensation from the palmar foot structures.

A retrospective study of 264 horses with injury of a collateral ligament (CL) of the DIP joint diagnosed using high-field MRI assessed the response to conservative management (box rest and controlled walking exercise for a minimum of 6 months; n = 173) compared with the response to ECSWT or RPWT (n = 57) (Dakin et al. 2009). Horses were divided into 4 groups: 1 = primary injury of a CL of the DIP joint; 2 = primary injury of a CL of the DIP joint plus related osseous injury; 3 = injury of a CL of the DIP joint combined with other soft tissue or unrelated osseous injury; 4 = injury of a CL of the DIP joint plus related osseous injury and other foot-related injury. Horses received 3 treatments at 2 week intervals (1000 shocks per CL). An excellent outcome was defined as a return to full athletic function for a minimum of 6 months.

Omitting horses which had other nonfoot related lameness or were lost to follow-up, an excellent outcome was achieved in 44.0% of horses in group 1, 43.2% in group 2, 28.1% in group 3 and 14.6% in group 4. There was no association between age, breed, duration of lameness or presence of increased radiopharmaceutical uptake at the insertion of the CL of the DIP joint in the distal phalanx and outcome.

There was no significant effect of ECSWT or RPWT (P = 0.485); when only groups 1 and 2 were assessed there was still no significant effect (P = 0.27). However in groups 1 and 2 13% had an excellent outcome with conservative management compared with 25% which received ECSWT or RPWT; whereas in groups 3 and 4, 9% had an excellent outcome with conservative management compared with 13% which received ECSWT or RPWT. The study power was low (24% with P = 0.05); to achieve a study power of 80% with a similar proportion of horses responding to treatment a sample size of 250 horses would require treatment using RPWT or ECSWT.

The limited efficacy of RPWT and ECSWT for treatment of CL injuries of the DIP joint may reflect the small proportion of the ligament which is accessible for treatment, the tendency for injuries to be worst distally and the degenerative nature of some lesions (Dyson et al. 2008).

References

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Saturday 11th September 2010

12.00–12.20
Formulating a treatment plan: based on leverage testing evaluations

Gene Ovnicek
506 State Hwy 115, Penrose, Colorado 81240, USA.

Diagnosing and treating lower limb lameness in horses has improved significantly over the last 15 years. The advancement in diagnostic equipment provides clear images of both hard and soft tissue. Digital radiographs, ultrasonograms and MRI technology are the tools commonly used in diagnosing lameness causes and physiological changes or anomalies. However, treatment prescriptions for these lameness issues can vary considerably from one practitioner to another. The inconsistency in the prescriptions and, therefore, the results of treatment may largely be due to the fact that the above mentioned diagnostic equipment cannot measure or quantify pain. Therefore, diagnostic nerve blocks are commonly used to locate the region of pain. Nevertheless, the quantity of pain and the exact location within the joint or capsule is not always clear and treatment success therefore varies.

The procedures for diagnosing lameness can be very time consuming and can therefore be expensive. In some case, one can only speculate as to the exact structures that may be affecting the current condition. There is usually no way of knowing if physiological changes or anomalies seen through the various diagnostic results are the actual cause of the current lameness or are nonpainful chronic lesions. It can be difficult to prescribe treatment for a lameness that is assumed in a general area with no assurance that the clinical findings are in fact acute or chronic at the time of the examination.

Over the last 4 years I have been using an approach of ‘asking the horse’ where they hurt and also what makes the pain subside. Bilateral leverage testing is a unique process in that pain can be identified in specific segments of the distal limb by raising each segment of the ground surface of the horse’s foot. The heel, toe, quarters (sides), toe quarters and heel quarters are the primary segments that are focused on. Significantly raising (elevating) one area of the foot will stretch (or add tension to) the connective tissue in the region above the segment that is raised. At the same time, this will compress the joint surface and connective tissue in the region opposite to the segment that is raised. At the same time, this will compress the joint surface and connective tissue in the region above the segment that is raised. This process is also unique because you can then raise the foot segment diagonal to the painful region and, in many cases, find relief to the pain, which can offer some specific guidelines for treatment.

I spent many years placing a wedge under the various segments of the foot to try to sort out what the horse liked and did not like, but this was time consuming and not very accurate. The current leverage testing protocol I use is relatively fast and accurate if you have a device you can actually attach to the foot. Once the leverage testing device is placed upon a horse’s foot, the horse is asked to bear full weight on that foot and the leverage device by asking them to pick up the opposite foot. The willingness or unwillingness to pick up the foot not being tested and subsequently bearing weight on the foot with the device attached, will help determine the amount of pain or comfort that may exist in the foot being tested. When you couple that observation with other visual indicators gathered from the horse, you are able to ‘score’ that segment of the foot. The general work-up procedure is conducted by raising all segments of the foot and scoring each location based on the various comfort/discomfort indicators. I always move diagonally from one segment to the opposite segment, rather than in a circular motion around the bottom of the foot. This protocol seems to yield more tissue specific data.

Once the full leverage testing procedure has been completed, you will have a scoring sheet with numbers relating to the 8 segments of the foot. I use a scale of 0 to -3 for the pain responses (discomfort) and 0 to +3 for the more comfortable responses. Through the severity of the scores and their location, veterinarians have a guide they can use to further investigate the foot/limb with the other diagnostic imaging resources available to them (i.e. radiographs, MRI, etc.). At the same time, the scores gathered from the leverage testing can help guide the farriers in their hoof balance examination and hoof preparation because hoof imbalances are often highlighted in the leverage testing results. Therefore, with the veterinarian and farrier having access to the same information regarding pain and comfort, they can better formulate a treatment approach that can offer the horse relief from the discomfort and improve their ability to heal over time.

In my experience with coordinating leverage testing results with my approach to trimming and shoeing, I have been able to offer many horses the ability to heal common lesions or soft tissue strains in and around the DIP joint. In cases where the scoring disparity from one segment of the foot to the diagonal segment is greater than 3 points, I have found it helpful and necessary to use temporary wedges on one side of the foot and not on the other. However, I always trim the foot to a balanced condition using the functional sole plane. If I need to add any sort of wedge or mechanical relief, I build that into the shoe or use materials that can easily be adjusted. This way, I can make any necessary changes in a few days or a few weeks, without having to completely re-shoe the horse. Although this approach is unconventional, I have seen great results because we have been able to significantly unload certain structure for a short period of time so they can begin to heal. I never look at these balance adjustments as a long-term application. However, by asking the horse what they like and do not like, I feel I am able to improve the level of soundness in more horses and in a shorter period of time by giving them what they ask for.

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Next Congress:

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Regional Anaesthesia
Chaired by Sarah Boys-Smith

16.00–16.20
Anaesthesia of the carpus/metacarpus and hock/metatarsus

Tom Hughes
The Liphook Equine Hospital, Forest Mere, Liphook, Hampshire GU30 7JG, UK.

In athletic horses, forelimb lameness associated with the carpal joints and proximal metacarpus is common. Similarly, pain arising from the structures of the proximal metatarsus and distal tarsus is a common cause of hindlimb lameness in working horses of all disciplines. The synovial articulations of the carpus and distal tarsus may be affected by synovitis, osteoarthritis, fractures and soft tissue injuries. Pain arising from the proximal metacarpus and metatarsus is frequently considered to result from inflammation of the proximal one third of the suspensory ligament (PSL), often termed proximal suspensory desmitis (PSD); however, lesions of the enthesis of the PSL, the proximal metacarpal/tarsal bones and other important soft tissue structures such as the accessory ligament to the deep digital flexor tendon may also be the cause of lameness that is isolated to that region. Effusion of the carpal joints is readily identified on palpation; however, other palpable abnormalities that could be used to reliably identify lesions of the proximal metacarpus/carpus or metatarsus/distal tarsus are infrequently encountered. A reduced range of motion on examination and an exacerbation of lameness following flexion of the carpus or proximal hindlimb may lead to a suspicion of carpal or tarsal pain but such findings should be corroborated by diagnostic regional analgesia or diagnostic imaging. Abnormalities seen on radiographic and ultrasonographic examination may be subtle or incidental with a substantial overlap of the normal and abnormal appearance of the structures affected. Thus, the diagnosis of lameness in the region of the proximal metacarpus/carpus and proximal metatarsus/tarsus is heavily reliant on the findings of diagnostic regional analgesia. As there is considerable overlap of the effects of nerve and joint blocks in this region it is vital that the diagnostician is fully aware of the structures that may be anaesthetised by each nerve and joint block. Ultimately, more advanced imaging techniques such as MR imaging may be required to establish a diagnosis in challenging cases.

Diagnostic analgesia of the proximal metacarpus

Innervation of proximal metacarpal structures is provided by the medial and lateral palmar nerves. The lateral palmar nerve divides to form a deep branch that further divides to form the medial and lateral palmar nerves as well as a branch that enters the proximal suspensory ligament. To remove skin sensation from the region dorsal branches of the ulna nerve and the musculocutaneous nerve also must be considered but they are not routinely included in diagnostic analgesia techniques.

To provide analgesia to the proximal metacarpus, the high palmar (high 4-point) block has been used although more recently techniques aimed at analgesia of the lateral palmar nerve above the level at which the nerve branches have become popular. To perform the high palmar block, 2 needles are directed to the palmar aspect of the third metacarpal bone axial to the second and fourth metacarpal bones at the level where they begin to taper to deposit local anaesthetic solution over the palmar metacarpal nerves. Needles directed between the suspensory ligament and deep digital flexor tendon at the same level deposit local anaesthetic solution over the palmar nerves.

Accidental penetration of the carpal or tarsal joint occurred in 17% of specimens in which a standard high palmar block was performed and 67% of specimens where the block was performed within 2.5 cm of the carpal or tarsal joint (Ford et al. 1989). The carpal or tarsal joint directly communicates with the middle carpal or tarsal joint therefore penetration of that joint during a high palmar block may confound the interpretation of block results. In order to avoid this hazard, 2 techniques have been proposed for blocking the lateral palmar nerve proximal to the suspensory and palmar metacarpal nerve branches.

The lateral palmar or Wheat block is performed by inserting a needle into the accessory-metacarpal ligament distal to the accessory carpal bone. This technique does, however, frequently lead to inadvertent puncture of the carpal sheath. Recently, therefore, a second technique has been proposed in which the lateral palmar nerve is blocked as in courses over the medial aspect of the accessory carpal bone (Castro et al. 2005). When this technique was performed in cadaver limbs, the carpal sheath was not punctured and it is the author’s preferred technique for analgesia of this region. The medial palmar nerve may be blocked as it is in a high palmar technique to provide more complete analgesia.

Diagnostic analgesia of the proximal metatarsus

Innervation of proximal plantar metatarsal structures is provided by the medial and lateral plantar nerves, which are branches of the tibial nerve. Innervation to the PLS is provided by a deep branch of the lateral plantar nerve. Several analgesic techniques have been described aimed at the deposition of local anaesthetic solution adjacent to the medial and lateral plantar nerves; however, on evaluation of 2 common techniques, the tarsal sheath or the tarsometatarsal joint were punctured in a large proportion of injection attempts confounding the interpretation of these blocks.

Recently, a single injection technique has been used to inject local anaesthetic solution around the deep branch of the lateral plantar nerve. A 25 mm long needle is inserted 15 mm distal to the head of the fourth metatarsal bone and axial to the fourth metatarsal bone. When the technique was performed in cadaver limbs, blue dye was successfully deposited around the deep branch in 18 of 19 limbs injected and in the remaining limb dye was found within the tarsal sheath (Hughes et al. 2007).

References


Regional analgesia has been used routinely for musculoskeletal diagnostic nerve blocks and regional analgesia for standing surgical purposes. It is only more recently that a greater variety of surgical procedures have been performed in the head and the true value of desensitising these tissues has become apparent. The indications for regional analgesia in the head are to provide analgesia and selective paralysis of structures to facilitate ancillary diagnostic or surgical procedures and some blocks can be used as diagnostic nerve blocks. Procedures performed routinely where local analgesia greatly facilitates the technique include eyelid surgery, dental surgery and periodontal procedures, parasatal sinus surgery, mandibular fracture repairs and transendoscopic laser surgery. Diagnostic techniques to localise pain can be used where temporomandibular joint pathology is suspected or to attribute significance to dental lesions in dysphagic cases or to test the efficacy of treatment techniques for head shaking. It should be assumed that the application of any nerve blocks to the head will be resented by the horse and therefore it is strongly recommended that these techniques are practised in horses that are already well sedated. My preference is to combine the regional analgesia with a multimodal approach involving benzodiazapine/alpha 2 adrenoceptor agonist sedation, parenteral analgesia with opiates and nonsteroidal anti-inflammatory drugs and local analgesia. The techniques are easily practised in the field but the advantages of performing most head procedures in a clinic where the environment can be controlled and any complications can be managed far outweighs the disadvantages of having to transport the horse. Where possible, I recommend that horses are restrained in stocks for better safety of clinicians and lay-spectators.

Local anaesthetic drugs for head nerve blocks

<table>
<thead>
<tr>
<th>Drug</th>
<th>Features</th>
<th>Applications</th>
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<tbody>
<tr>
<td>Prilocaine</td>
<td>Rapid onset, duration &gt; 1 h</td>
<td>Short procedures e.g. wolf tooth removal, subgingival infiltration</td>
</tr>
<tr>
<td>Lignocaine</td>
<td>Rapid onset, duration &gt; 45 min</td>
<td>Short procedures e.g. wolf tooth removal, subgingival infiltration, lacerations</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>Medium onset, licensed, duration 90 min</td>
<td>Dental extractions, periodontal treatments, minor fracture repairs, enucleations, sinus surgery</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>Markedly slower onset, duration 2–4 h</td>
<td>Prolonged procedures</td>
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<tr>
<td>Cinchocaine</td>
<td>Topical application on mucous membranes</td>
<td>Occasional incisor treatments</td>
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Benefits of nerve blocks of the head

1. Better analgesia
2. Reduced sedative plane
3. Better compliance
4. More accurate work
5. Less iatrogenic trauma

Nerve blocks for oral surgery

1. Mental nerve block
2. Inferior alveolar nerve block
3. Infraorbital block
4. Maxillary nerve block
5. Subgingival infiltration
6. Periodontal block

Alternative routes:

- Subgingival

**Mental nerve**

- Desensitis skin and gingiva of lower lip depressor labii inferioris muscle
- Remnant that emerges from mental foramen
- Incisors innervated by branch that continues in the bone

To perform mental nerve block:

- Elevate muscle dorsally.
- Introduce needle into mental foramen or deposit LA around emerging nerve.

**Infraorbital nerve block**

Maxillary V emerges from foramen and fans out.

Foramen lies under levator nasi superioris muscle.

Retrobulbar nerve block can be used to desensitise the adnexa and extraocular muscles to facilitate enucleation in conjunction with a palpebral nerve block.

**Maxillary nerve**

Inferior alveolar nerve (mandibular V).

Location for inferior alveolar block.

Imaginary line: ventral mandible to lateral canthus: 1 cm caudal. Intersection with second imaginary line along occlusal surfaces of maxillary cheek teeth.

**Intra-articular temporomandibular joint block**

Can be used as a diagnostic nerve block. Retrobulbar nerve block can be used to desensitise the adnexa and extraocular muscles to facilitate enucleation in conjunction with a palpebral nerve block.

Complications of head nerve blocks

- Infra-orbital neuropaxia
- As infraorbital/maxillary nerve sensation returns
- Facial sweating
- Sympathetic chain desensitisation during maxillary block
- Facial haematoma
- Puncture of maxillary, ethmoidal or superficial temporal arteries
- Globe protrusion
- Use of excessive volume of local anaesthetic - paralysis of extraocular muscles
- Eyelid prolapse and possible corneal abrasion
- Septic cellulitis
- Staphylococcal/strep infection introduced by inferior alveolar nerve causing gross painful swelling - aseptic preparation

References


Saturday 11th September 2010

16.40–17.00

Anaesthesia of the proximal limb

Marcus Head
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No abstract submitted
Regional anaesthesia was first performed in 1884 by Karl Koller, an Austrian ophthalmologist in Vienna, using cocaine for eye surgery. This was followed in 1898 by August Bier, a German surgeon, using cocaine for spinal anaesthesia.

The advantages of regional anaesthesia have been debated ad infinitum: reduced cardiorespiratory complications, less thromboembolic events, modification of the stress response, improved patient satisfaction to name but a few. However, the overwhelming benefit is one of superior perioperative analgesia. This applies to both central and peripheral nerve blockade.

The popularity of regional anaesthesia fluctuated throughout the 20th Century mainly due to adverse incidents. The most famous of these was the Woolley and Roe case. In 1947, in Chesterfield, 2 men became paraplegic following spinal anaesthesia given by the same anaesthetist, using the same drug, on the same day, in the same hospital. It was originally thought that phenol had contaminated the local anaesthetic ampoules, but later evidence suggests the glass syringes used were contaminated with descaling liquid. Although this refers to spinal anaesthesia and I will concentrate my talk on peripheral nerve blockade, the adverse event virtually halted its use for a quarter of a century and still influences the anaesthetic community’s drive to place safety at the top of our priorities.

Between 1884 and the mid-1990s the main advances in regional anaesthesia have been drugs and a range of anatomical techniques to locate the nerves. Two landmark techniques have dominated the 20th Century, both using the application of surface anatomy to identify an entry point for needle insertion, but different endpoints being sought to infer needle tip placement close to the nerve being targeted.

The ‘parasthesia technique’ uses the sensation of parasthesia in the distribution of the nerve being blocked as the endpoint for needle placement and thus local anaesthetic injection. This was practised widely with good results in skilled hands until the advent of the peripheral nerve stimulator. It was, however, associated with significant patient discomfort.

Peripheral nerve stimulators, although first used in the early 1900s, did not reach widespread clinical use until the 1980s. A current is passed through the needle to stimulate the nerve as the needle is advanced towards it until a specific motor response is obtained. The closer the tip is to the nerve, the lower the current required to stimulate the nerve, thus by getting to a point whereby when the current was reduced the motor response ceased it was believed one could be close to, but not in, the nerve.

Both of these are blind techniques, which although efficacious and associated with minimal risk of serious neurological sequelae, rely on anatomy which we all know to be naturally variable and are essentially blind techniques.

In the late 1990s people began to experiment with the use of ultrasound to visualise peripheral nerves and with the development of more compact, mobile, user-friendly and affordable machines, this practice has expanded rapidly during the last decade. This has occurred for a number of sound reasons and some speculation!

With modern portable devices (as used in equine practice) it is now possible to noninvasively directly visualise the anatomy, the needle, neural structures and local anaesthetic spread in real time. It seems intuitive that this should be more efficacious and safer than the more traditional landmark techniques.

Studies to date have clearly demonstrated some benefits in comparison to nerve stimulator methods: reduced volumes of local anaesthetic required to block a nerve or plexus; faster onset blocks; longer block duration; less pain during block performance and improved patient satisfaction and the ability to access nerves previously ‘out-of-range’.

However, the big questions of efficacy and safety, in terms of nerve damage, remain to be clarified. The reasons for this are 2-fold - experienced practitioners of the nerve stimulation technique report success rates of over 95% and the incidence of permanent neurological deficit following a femoral nerve block is 1 in 5000, therefore to demonstrate improvement in these areas will be incredibly difficult and require trials the scale of which are impractical.

As with many advances some of the inadvertent findings are the most intriguing. It was always believed that intraneural injection was potentially dangerous and that when using nerve stimulation technique no motor response corresponded to extra neural needle placement. Both of these have been disproved convincingly with the use of ultrasound for regional anaesthesia and I will expand on these.

The challenges for the future are to ensure our education processes are robust to convert this technology into better and safer blocks. Clinical trials may be able to better inform us of the precise local anaesthetic spread pattern required to block a specific nerve/plexus and these may involve the introduction of 3D images.

Further reading

NOTES
Proceedings of the
49th British Equine Veterinary
Association Congress
BEVA

Sep. 8 – 11, 2010
Birmingham, United Kingdom

Next Congress:

BEVA Congress
British Equine Veterinary Association
7-10th September 2011 • Liverpool, UK

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Dealing with dystocia in the field

Peter Ravenhill
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Dystocia in the broodmare is one of the few true emergencies that equine practitioners encounter. The actual incidence of dystocia varies among equine populations with Thoroughbreds at around 4% and Draught mares approaching 10%. The explosive nature of parturition in the mare can make dystocia a life threatening event for both the mare and foal. Therefore, a rapid, well coordinated approach to dystocia in the field is essential, while all precautions must also be made to minimise reproductive tract trauma to the mare (to maximise the chance of future breeding).

The first stage in the response to a dystocia must be immediate telephone advice from the veterinary surgeon to the stud personnel (usually while driving to the stud farm!), as in cases such as premature placental separation (‘red bag’ delivery) or vagino-rectal perforation by foal limbs. Simple immediate action by stud personnel can be a major factor in the outcome of the case.

Another important decision to make is whether the veterinary surgeon should actually attend in the field or if it is going to be advantageous to immediately transport the foaling mare to an equine hospital and this will often depend on the expertise of the stud personnel and the distance from farm to hospital.

Equipment

The attending veterinary surgeon MUST have a comprehensive dystocia kit readily available in the car and, in my opinion, this should include foaling ropes and handles, a copious supply of obstetrical lubricant (powdered ‘lube’ and stirrup pump and sterile stomach tube very useful), drugs for sedation and possibly even induction of general anaesthesia of the mare, simple ‘ambibag’ type foal resuscitator and foal oro-tracheal cuffed tube (for EXIT) and drugs for foal resuscitation.

Ideally access to a comprehensive fetotomy kit is also desirable.

Four procedures to resolve dystocia in the mare

1) Assisted vaginal delivery (AVD) with the mare delivering vaginally under standing sedation.
2) Controlled vaginal delivery (CVD) with the mare anaesthetised, hind legs elevated and the clinician in complete control of the delivery.
3) Fetotomy - where the fetus is cut into more than one piece for removal vaginally, usually in a standing sedated mare.
4) Caesarean section - in an anaesthetised mare.

In most cases of management of dystocia in the field, AVD and fetotomy are appropriate procedures, with CVD and caesarean section usually reserved for the Equine Hospital, although in extreme cases, where caesarean section is not an option (i.e. on economic grounds), then CVD can be attempted in the field.

These procedures and approach to different types of dystocia in the field will be considered in this presentation.
Dealing with dystocia in a referral hospital

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A mare with dystocia arriving at a referral hospital represents a true emergency, as the successful delivery of a live foal is dependent on the time taken to deliver the foal. It is essential that everyone within the clinic knows what to do when the mare arrives and that each step in the process is quickly but carefully carried out. Assisted vaginal delivery has often been attempted prior to admission to the hospital, therefore attempts at assisted vaginal delivery, particularly if the foal is still alive, are limited to save time.

The process of delivery of a live foal at a referral hospital follows 2 steps. Firstly, controlled vaginal delivery and, if that is not successful, caesarean section. If the foal is dead then fetotomy may be considered to save the mare. However, caesarean section may still be warranted if the dead foal cannot be delivered with a minimal number of cuts.

Controlled vaginal delivery

Once the mare has arrived at the referral hospital she is placed in an induction stall and anaesthesia is induced. Once recumbent, the hindquarters are hoisted with hobbles around the pasterns. General anaesthesia prevents muscular straining and, combined with gravity provided by hoisting the mare’s hindlimbs, enables careful repositioning of the foal. As with all manipulations, it is important that great care is taken to reposition the foal with as few manipulations as possible and to use a large volume of lubricant solution to try to prevent trauma to the reproductive tract. While controlled vaginal delivery is attempted, the mare’s abdomen is clipped and prepared ready for aseptic surgery. If attempts at controlled vaginal delivery have not been successful within 15 min then the mare should be moved to theatre for caesarean section.

Caesarean section

If attempts at controlled vaginal delivery are not successful or on initial examination it appears that a live foal cannot be delivered via controlled vaginal delivery, a caesarean section should be considered. The technique for caesarean section has been well described elsewhere and, although several different approaches to the abdomen are possible, the author prefers a ventral midline celiotomy. The most important complications that may arise as a result of caesarean section include uterine haemorrhage, retained placenta and infertility as a result of uterine adhesions or scarring of the rest of the reproductive tract.

Fetotomy

Where the foal is known to have died, a fetotomy may be performed in the standing mare under sedation and local anaesthesia, most often provided by epidural blockade. It is essential that a fetotomy is performed using the minimum number of cuts and manipulations such that trauma to the mare’s reproductive tract that may lead to scarring and infertility in future is minimised. In order to achieve this, it is very important that the clinician is fully aware of the various cuts that should be made given the presentation of the foal and surgery should be carefully planned to ensure that as few cuts as possible are made. The equipment required for a successful fetotomy must be present and well maintained. If it is felt that a foal will not be delivered with 3 or fewer cuts, a caesarean section should be strongly considered.

Outcome

The outcome of foal delivery in a referral hospital has been reported in 2 contrasting hospitals, one where mares arrived at the facility soon after the start of foaling and another where the mares arrived much later (Freeman et al. 1999; Byron et al. 2003). In the hospital in an intensive breeding area, 71% of dystocias were treated by controlled vaginal delivery and only 25% by caesarean section. Of those horses treated, 91% of the mares survived, 42% of the foals were delivered alive and 30% of foals survived to discharge. In the more extensive breeding area, by comparison, of the mares referred to the hospital, 42% had foals delivered by controlled vaginal delivery and 58% required caesarean section. Eighty-five percent of mares that had a nonelective caesarean section and 71% of mares who had a foal delivered by controlled vaginal delivery survived. In that population of horses, only 11% of the delivered foals were alive at the time of delivery and only 5% survived to discharge. Undoubtedly the difference between the 2 hospitals was the time taken for the mares to arrive at the hospital’s facility underlining the importance of rapid referral and resolution of dystocia. Foals that survived were delivered within 90 min from the rupture of the fetal membranes.

The future breeding success of mares that have had a foal delivered by caesarean section is affected but that may be the result of attempts to deliver the foal performed prior to surgery rather than the surgery itself. In one study (Byron et al. 2003) the predystocia live foaling rate in the population of mares affected was 84% and post dystocia overall 67% (59% in the same season). Mare survival following fetotomy was 96% and 100% in 2 recent studies (Carluccio et al. 2007; Nimmo et al. 2007). The future breeding success of mares that have had a foal delivered by fetotomy was also good with a live foaling rate of 83% reported (Nimmo et al. 2007).

References and further reading


Saturday 11th September 2010

10.00–10.30

Recognition and control of multi-drug resistant *P. equorum* infections in foals

**Wendy Vaala**

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The most pathogenic parasite among foals and weanlings, *Parascaris equorum* (*P. equorum*), produces a constellation of clinical signs including respiratory disease associated with larval migration through the lungs and intestinal disease associated with larval and adult parasite development in the small intestines (Austin et al. 1990). Signs of respiratory disease include coughing, low-grade fever and mucopurulent nasal discharge (Austin et al. 1990). Signs of intestinal disease include weight loss, unthriftiness, enteritis, impaction colic and occasionally fatal peritonitis secondary to bowel rupture (Southwood et al. 1998; Cribb et al. 2006). Even foals treated surgically for ascarid impactions have poor long-term survival rates (Cribb et al. 2006).

Within 48 h following infection, infective larvated eggs hatch within the foal’s alimentary tract. Larvae emerge and migrate via the portal vein to the liver, are transported to the lungs via the vena cava and enter alveoli. After completing another molt, *Parascaris* larvae ascend to the tracheobronchial mucus, are swallowed and arrive in the small intestines to undergo a final molt and mature into egg-laying adults. The prepatent period for *P. equorum* is ~75–80 days. Most juvenile horses acquire immunity by 8–18 months of age. Ascarid eggs are notoriously hardy and persist in the environment for many years despite temperature extremes. Pasture contamination from the previous year’s foal crop represents a significant source of infection for foals born the following year.

Macrocyclic lactones (ML), tetrahydropyrimidines and benzimidazoles are all licensed to control adult stages of *P. equorum*. Ivermectin (IVM) has documented efficacy against both larval and adult ascarid populations (DiPietro et al. 1988). Not surprisingly, IVM is one of the most frequently used dewormers in foals throughout the world, with many breeding operations administering the first dewormer to foals beginning at <8 weeks of age followed by intensive treatment intervals of <60 days. Within the last decade, failure of ML anthelmintics to reduce *P. equorum* faecal egg counts (FEC) has been reported in Canada, USA, South America and Europe (Boersema et al. 2002; Hearn and Peregrine 2003; Craig et al. 2007; Schougard and Nielsen 2007; Slocombe et al. 2007; Von Samson-Himmelstjerna et al. 2007; Lindgren et al. 2008; Lyons et al. 2008; Molento et al. 2008; Veronesi et al. 2009). On many farms with IVM resistant (*IVM/R*) ascarids, FBZ (10 mg/kg bwt) and pyrantel pamoate are still effective against neonates (Slocombe et al. 2007; Reineymeyer et al. 2008; Veronesi et al. 2009). However, there are recent reports documenting failure of tetrahydropyrimidines to reduce FECs among certain *P. equorum* populations (Lyons et al. 2008; Lind et al. 2009).

More than 2 decades ago, fenbendazole (FBZ) was proven to exert a larvicidal effect on migrating *P. equorum* larvae in experimentally infected pony foals (Vandermeyde et al. 1987). A more recent study confirmed the larvicidal efficacy of a 5 day regimen of FBZ against even an IVM resistant isolate of *P. equorum* in experimentally infected weanling foals (Reineymeyer et al. 2010). Sixteen foals, infected orally with larvated eggs from an IVM resistant isolate of *P. equorum*, were randomly allocated to one of 2 treatment groups: oral FBZ (10 mg/kg bwt) once daily for 5 days beginning on D11 post infection or a single dose of oral ivermectin (200 g/kg bwt) on D15 post infection. The geometric mean FEC of FBZ-treated foals was significantly lower (P<0.001) than that of IVM-treated foals with a 99.5% reduction in FEC. Mean numbers of adult Parascaris recovered post mortem were significantly lower (P<0.0018) in FBZ-treated foals resulting in 96.3% efficacy.

An effective ascarid control programme should reduce foal morbidity and mortality associated with pulmonary inflammation and intestinal disease due to immature and adult ascarids while minimising pasture contamination and reducing selection pressure for multi-drug resistant *P. equorum* populations. Several recommendations help accomplish these goals. Use only anthelmintics known to be effective against indigenous *P. equorum* populations by using FECR testing to monitor drug efficacy. Delay the first anthelmintic treatment until foals are ≥70 days of age, unless there are strong medical indications to begin larvicidal treatments earlier. Repeat deworming treatments at the longest intervals possible that protect foal health while minimising environmental contamination of both foal and adult ascarids, and are identified on a farm, incorporate the use of FBZ and tetrahydropyrimidines. A 5 day, larvicidal dose of FBZ is an effective method to treat new foal arrivals that may be harbouring occult MLR *Parascaris* infections and for synchronising an ascarid control programme among foals of varying ages. Manure composting at temperatures >45–60°C (Hebert et al. 2010), frequent manure removal and cross-grazing mare/foal pastures with ruminants are nonchemical strategies used to reduce environmental contamination.

**References**


Post partum complications in the mare

Peter Ravenhill
B & W Equine Group, Willesley Equine Clinic, Byams Farm, Willesley, Tetbury, Gloucestershire GL8 8QU, UK.

The post partum period is an extremely challenging time for the equine practitioner and a good knowledge of the sequence of post partum events in a normal mare is essential, so that any variation from normal can be investigated and rapid treatment given.

The post partum conditions in the mare that will be discussed in this presentation are as follows, including diagnostic procedures and treatment options:

1) Management of retained fetal membranes.
2) Post foaling rupture of the middle uterine artery within the broad ligament (post foaling haemorrhage).
3) Intra-partum rupture or perforation of the uterine wall.
4) Intra-partum rupture of the bladder.
5) Intra-partum laceration of the vulva, vagina and cervix and possible sequelae.
6) Post partum colic, e.g. colon displacement, colon torsion.
7) Management of recto-vaginal fistulae.
8) Prolapse of the bladder, uterus or rectum.
Identification and management of the high risk mare

Wendy E. Vaala

Intervet Schering Plough Animal Health, S1476 Pleasant View Road, Alma, Wisconsin, USA.

Several retrospective necropsy studies examining the causes of abortion, stillbirth and perinatal death in horses showed that infectious placentitis and delivery complications associated with dystocia and birth trauma were the most common causes of perinatal mortality (Giles 1993). Surviving neonates often require intensive therapy for sepsis, hypoxic-ischaemic encephalopathy (HIE) and/or dysmaturity. Early recognition of in utero complications allows therapy to begin prepartum, ensures an attended delivery and facilitates neonatal supportive care during or immediately after parturition.

Mares at risk for abnormal pregnancies and compromised foals can be grouped into 3 general categories: 1) Mares with a history of past complications such as premature placental separation, placentitis, premature delivery; 2) Mares experiencing a problem with their current pregnancy due to severe maternal illness and/or reproductive tract disease; 3) Mares suffering unpredictable delivery complications (dystocia, umbilical cord accidents). Table 1 lists adverse periparturient events and complications to anticipate.

A suggested database for any mare suspected of having a jeopardised pregnancy includes: signalment of mare (age, parity); past reproductive history (outcome of past pregnancies, average gestation length); general health and current reproductive history (vaccination/deworming history, date last bred, current medical conditions, list of current medications); prepartum evaluation and diagnostics (complete physical, rectal palpation, vaginal examination if indicated, transrectal/transabdominal ultrasonography, routine haematology and biochemistries, progestagen concentration, cultures).

Transrectal ultrasonography allows evaluation of the pericervical placenta to detect thickening and premature placental separation. Normal measurements for the combined thickness of the uteroplacental junction (CTUP) are as follows (Renaudin et al. 1997):

- Gestation Days 271–300: CTUP ≤10 mm
- 301–330: CTUP ≤10 mm
- 330 to term: CTUP ≤12 mm

CTUP measurements may be slightly higher in Warmbloods and lower in ponies.

Transabdominal ultrasonography is used to evaluate fetal size, position, activity and heart rate, fetal fluid volume and clarity and placental thickness and integrity. During late pregnancy, warning signs of uteroplacental disease and potential fetal compromise include persistent bradycardia (FHR <50 beats/min), sustained tachycardia (>120 beats/min) in the absence of fetal movement, loss of fetal movement and tone, increased or decreased volumes of allantoic or amniotic fluid, marked increase in fluid echogenicity, large or increasing areas of placental detachment and increased CTUP (≥15 mm) (Reef et al. 1996). Measurements of fetal size, using diameter of eye orbit and aorta, should be performed in pregnancies of uncertain or prolonged gestation length or when IUGR is suspected.

Abrupt changes in progestagen concentrations during the last trimester have been associated with fetoplacental compromise. Progestagen concentrations average between 2 and 6 ng/ml during the last trimester until around Day 310 (LeBlanc et al. 2004). A sudden decrease in plasma progestagen often heralds impending abortion, whereas a sudden rise in progestagen is

<table>
<thead>
<tr>
<th>Table 1: Periparturient events and fetal/neonatal events to anticipate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periparturient event</td>
</tr>
<tr>
<td>-----------------------------------</td>
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<tr>
<td>Precocious udder development, premature lactation</td>
</tr>
<tr>
<td>Excessive abdominal enlargement</td>
</tr>
<tr>
<td>Prolonged gestation, agalactia, dystocia, placental oedema and premature separation</td>
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<tr>
<td>Prolonged gestation</td>
</tr>
<tr>
<td>Premature placental separation</td>
</tr>
<tr>
<td>Dystocia</td>
</tr>
<tr>
<td>Colitis in the mare</td>
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<tr>
<td>Aged broodmare</td>
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<tr>
<td>Colic in the mare</td>
</tr>
<tr>
<td>Heavy (&gt;10% foal’s bw) and/or discoloured placenta</td>
</tr>
</tbody>
</table>
Table 2: Therapeutic agents commonly used to treat placentitis in the mare

<table>
<thead>
<tr>
<th>Proposed action/rationale for therapy</th>
<th>Drug/therapy</th>
<th>Dose, route, frequency of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial</td>
<td>Trimethoprim sulphonamethoxazole</td>
<td>15–30 mg/kg bwt, per os q. 12 h</td>
</tr>
<tr>
<td></td>
<td>Potassium penicillin</td>
<td>22,000 u/kg bwt, i.v. q. 6 h</td>
</tr>
<tr>
<td></td>
<td>Procaine penicillin G</td>
<td>22,000 u/kg bwt, i.m. q. 12 h</td>
</tr>
<tr>
<td></td>
<td>Cefiotaur</td>
<td>2.2 mg/kg bwt, i.v. or i.m. q. 12 h</td>
</tr>
<tr>
<td></td>
<td>Cefazolin</td>
<td>20 mg/kg bwt, i.v. q. 6 h</td>
</tr>
<tr>
<td></td>
<td>Gentocin</td>
<td>6.6 mg/kg bwt, i.v. or i.m. q. 24 h</td>
</tr>
<tr>
<td>Anti-inflammatory (anti-prostaglandin, anti-cytokine)</td>
<td>Flunixin meglumine</td>
<td>0.5–1.0 mg/kg bwt i.v. q. 12 h</td>
</tr>
<tr>
<td></td>
<td>Phenybutazone</td>
<td>2–4 mg/kg bwt, i.v. or per os q. 12–24 h</td>
</tr>
<tr>
<td></td>
<td>Pentoxifylline</td>
<td>8.5 mg/kg bwt, per os q. 8 h</td>
</tr>
<tr>
<td>Tocolytic/uterine quiescence</td>
<td>Altenogest</td>
<td>0.088 mg/kg bwt, per os q. 24 h</td>
</tr>
<tr>
<td>Anti-oxidant</td>
<td>Vitamin E (Tocopherol)</td>
<td>1000-8000 iu per os q. 24 h</td>
</tr>
<tr>
<td>Oxygen delivery</td>
<td>Intranasal oxygen</td>
<td>10–20 l/min</td>
</tr>
</tbody>
</table>

NOTES

frequently associated with a stressed but sustainable pregnancy. Therapy for high-risk pregnancies has multiple goals: 1) Maintenance of uterine quiescence through the use of tocolytics (altenogest) and anti-cytokine agents (pentoxifylline, flunixin meglumine); 2) Treatment of infection; 3) Enhancement of fetal maturation if premature delivery is anticipated (steroids, domperidone); 4) Preservation and support of placental function (e.g. oxygen therapy, nutritional support, anti-oxidant therapy). Delivery should be attended and in some cases may be induced. Indications for induction include impending maternal demise or the need for assisted delivery (e.g. hydrops, prepubic tendon rupture, pelvic trauma). Induction is associated with an increased risk of dystocia and delivery of a compromised neonate. These complications should be anticipated and a course of action predetermined. Post partum, gross and histopathological examination of the placenta is essential to characterise uteroplacental dysfunction. Umbilical cord anomalies may be overlooked. Unusually long cords have been associated with hypoperfusion of the allantochorion and are prone to cord torsion and fetal strangulation leading to hypoxia, death and abortion. Excessively short cords place increased traction on the placenta during delivery and may predispose to premature placental separation.

Research using experimental models of placentitis (LeBlanc et al. 2004; Bailey et al. 2007) has helped elucidate the pathophysiology associated with inflammatory insults in general. The typical route of infection is transcervical and the most common bacterial pathogens are Streptococcus zooepidemicus, E. coli, Klebsiella and Pseudomonas. Bacterial invasion of placental tissues stimulates release of pro-inflammatory cytokines and prostaglandins E2 (PGE2) and F2α (PGF2α) which stimulate premature labour and delivery. Treatment strategies for placentitis are listed in Table 2.

References


Identification and management of the high risk foal in practice

Peter R. Morresey
Rood and Riddle Equine Hospital, Lexington, Kentucky, USA.

Introduction
A healthy foal begins with consideration of the intrauterine environment and perinatal events. Timely assessment of neonatal parameters and detection of abnormalities can yield valuable information. Informed decisions regarding on-farm treatment and prognosis can then be made.

Identification of the high risk neonate
Conditions associated with the high risk neonate may be conveniently placed into 3 categories:

- **Maternal conditions:** systemic problems and those relating to reproductive health. Fever, gastrointestinal compromise, endotoxaemia and surgical manipulation are deleterious to the fetus. History of previous neonatal compromise, placental pathology and prepartum loss of colostrum all alert the clinician to potential neonatal difficulties.
- **Parturient events:** abnormal gestation length, abnormalities of the birth canal, prolonged labour, dystocia, premature placental separation and premature rupture of the umbilical cord. Meconium in the amniotic fluid or amnion may be the only indication of aspiration.
- **Neonatal conditions:** fetal distress may be manifest as growth retardation, meconium staining or indicated indirectly by placental disease. Trauma during delivery may not be apparent until a few days of age. Incomplete ossification of the cuboidal bones of the carpus and tarsus impedes future athleticism. Abnormal behaviour and the inability to stand and suckle lead to a lack of colostral intake preventing adequate passive immunity.

Evaluation at birth
Haematological values in the neonatal foal differ from the adult at first but rapidly assume those values. Normal physiological changes must be appreciated before abnormal values can be accurately interpreted. Should the newborn foal fail to achieve the following goals in a timely fashion, suspicion of neonatal compromise should be raised:

- **Sternal recumbency:** the foal should right itself and be able to remain sternal within minutes of birth.
- **Standing:** within 60 min (range of 15–165 min). Compromised neonates tend to remain recumbent longer, further exposing themselves to pathogens.
- **Suckle reflex:** usually develops within 20 min of birth, although may be much sooner.
- **Suckling:** the foal should suckle the mare within 2 h (range 35 min–7 h).
- **Urination:** first urination occurs at 6 h for colts, 10 h for fillies.

Stabilisation of the foal
If the foal is showing signs of distress, it may be prudent to transport the foal as soon as possible even if separately from the mare. Send colostrum from the mare for later administration and the placenta for examination if available.

- If hypothermic, ensure the foal remains warm. Use blankets, insulated foal covers or provide external sources of heat such as warmed fluid bags. Avoid excessively warming the hypovolaemic foal as increasing circulation at the periphery can lead to profound falls in blood pressure.

- If breathing difficulties are present, place an intranasal oxygen cannula. Insert the tip to the level of the eye socket. Portable oxygen tanks can be set to provide 5 l oxygen flow per min.

- Fluids should be administered if dehydration or hypovolaemia are present. Half the calculated deficit can be given rapidly prior to referral. Maintenance fluid rates for foals are higher than the adult horse, being 5–10% of bodyweight daily i.e. 2–4 l/kg bw/h. Consider all sources of fluid intake for the foal to avoid overhydration. If recumbent, exceeding 10% of bodyweight can promote pulmonary oedema formation. Glucose supplementation (2.5% or 5% dextrose in polyionic fluids) can be given if blood glucose levels are low, however, rapid rehydration of the foal should always use nonglucose containing fluids. Care must be exercised with the addition of glucose to fluids as oversupplementation results in hyperinsulinaemia and subsequent worsening of hypoglycaemia.

- Placement of an indwelling feeding tube will aid in administration of colostrum as well as provide a vehicle for continued feeding of the foal (if appropriate) during transport to the referral facility should this be distant from the farm. Ensure the foal is fed standing (if able to rise) or only when in sternal recumbency. Avoid overheeding the sick foal: feed 10% of the bodyweight of the foal as milk over a 24 h period.

- Antimicrobial therapy should not be delayed in the foal suspected of sepsis. Collection of a blood culture using aseptic technique before administration of antimicrobials is desirable to improve chances of yielding the causative infectious agent. This can be shipped with the foal.

- Anti-inflammatory treatments are also indicated in the foal that has sustained physical trauma or is febrile. The NSAIDs vary in their potential for gastric mucosal and renal toxicity, especially if used in the dehydrated patient.

- If neurological dysfunction is present, control of cerebral oedema and seizure activity are indicated. The onset of neurological dysfunction is usually delayed, becoming apparent after a 24–48 h period of apparently normal development. Control seizure activity in the first instance to avoid rapid exhaustion of the foal and secondary injuries predisposing to bacterial sepsis.

Referral
If the foal is sufficiently medically stabilised and the owner is compliant, transport to a referral facility is possible:

- **Timeliness:** nothing is worse than a referral too late. Increased costs of treatment to the owner coupled with a decreased prognosis result.
- **Owner financial resources:** hospitalisation will be expensive. Continuous nursing care is expensive but imperative.
Further reading


NOTES

- **Ensure secure vascular access**: if you place an i.v. catheter ensure that it will remain in place with all attachments.
- **History**: where possible, a written account encompassing treatment to the time of arrival at the hospital. Encourage the client to bring your billing/record sheets.
- **Up to date blood work is imperative**: blood collected before referral will likely be repeated, to establish both a baseline and to gauge response to previous treatments.
- **Mare compliance**: is it necessary for the mare to accompany the foal? If so, will she adjust to a hospital setting?
Neonatal intensive care: what it involves and is it worth it?

Wendy E. Vaala
Intervet Schering Plough Animal Health, S1476 Pleasant View Road, Alma, Wisconsin, USA.

What is involved?

Intensive care for neonatal foals requires several inescapable ingredients: 1) the philosophical commitment of the entire practice to provide ICU services; 2) trained technicians to provide round-the-clock nursing care and patient monitoring; 3) climate controlled environment equipped with "foal-friendly" fluid and oxygen delivery systems; 4) laboratory services capable of providing same day haematology and biochemistry results; 5) continuing education for mare/foal owners. Common conditions afflicting newborn foals include neonatal encephalopathy, septicaemia, dysmaturity, limb deformities, enteritis and colic. Sick newborn foals are like slowly burning fuses. Regardless of what disorder ignites the process, once a neonate stops nursing the downhill spiral escalates due to metabolic instability, multi-organ system failure and disruption of normal post partum adaptive processes. Successful outcomes depend on rapid diagnosis and treatment of specific diseases while managing secondary hypothermia, hypoglycaemia, hypoxia, hypotension, septicaemia, seizures and complications associated with recumbency.

The level of foal care varies from basic supportive nursing care including short-term O2 support and i.v. fluid and antimicrobial therapy provided on the farm to 24/7 nursing care in a clinic ICU capable of providing continuous fluid, nutritional and respiratory support and patient monitoring. In the latter environment, the most critical component is skilled nursing staff capable of obtaining venous and arterial samples, placing i.e. catheters and oxygen cannulas and intubation. Since NICUs are seasonal, a popular strategy for many practices is to support a critical core of skilled nurses year-round and hire a reliable team of seasonal 'nursing assistants' and volunteers during the foaling season.

A few simple stall renovations can facilitate administering fluids, oxygen and frequent feedings to weak foals in the shadow of their protective dams. A large mare/foal stall (12 x 18 ft., 3.7 x 5.5 m) with a removable partition is ideal. Sick foals require a well-ventilated, draught-free area and stall flooring that provides good traction and is easy to disinfect. Delivery of i.v. fluids to a well-ventilated, draught-free area and stall flooring that provides good traction and is easy to disinfect. Delivery of i.v. fluids to ambulatory and recumbent foals is made easier with the placement of swivel hooks in the ceiling above foal stalls and the use of long-term polyurethane jugular catheters, coiled i.v. fluid administration sets and surcingles. Infusion pumps are required to control fluid rates in critical patients or when continuous rate infusions are necessary. An oxygen source is essential and can include portable tanks, in-wall units or oxygen concentrators that require only an electrical source to operate. Bed mattresses with removable covers, water beds or customised padded 'wedges' are all acceptable bedding for recumbent foals. Synthetic fleece pads reduce the risk of decubital sores. Good lighting and ready access to electrical outlets and hand disinfection stations are also vital. Strict attention to aseptic technique and a heightened awareness of general hygiene is essential when working around compromised foals to reduce the risk of nosocomial infections.

Point-of-care monitors for glucose, lactate and blood gases are wise investments that quickly pay for themselves and can be used year-round for adult patients. Laboratory support that affords same-day results for haematology and serum chemistries is essential. An ultrasound machine with sector as well as linear scanners is indispensable since noninvasive ultrasonography is used to evaluate and diagnose lung consolidation, rib fractures, urorperitoneum, umbilical remnant infections, intestinal motility disorders and septic joint effusions. Indirect blood pressure monitors are affordable and invaluable when stabilising hypotensive foals suffering from septic shock, severe peripartum asphyxia and/or advanced prematurity. More expensive equipment expenditures may include a positive pressure ventilator, capnograph, pulse oximeter and ECG machine. During foaling season, a clinic’s pharmacy often must expand its inventory to include a ready supply of parenteral and enteral nutrition supplies, hyperimmune plasma, litre bags of crystalloid fluids and selected antibiotics, anti-convulsive drugs, inotropes and pressor agents.

Is it worth it?

Since the establishment of the first dedicated foal NICUs in the early 1980s, there have been numerous retrospective studies examining short-term survival and long-term prognosis for foals receiving critical care. Sepsis, peripartum asphyxia syndrome/ neonatal encephalopathy and altered states of maturity remain the most common neonatal disorders. Between 1981 and 1983, the overall survival rate among neonatal foals admitted to the first foal NICU in the USA was 54% (Baker et al. 1986) with 10% of the survivors dying within 2 years of discharge. The remaining

Table 1: Clinical parameters associated with survival/non-survival in neonatal foals

<table>
<thead>
<tr>
<th>Primary condition</th>
<th>Variables associated with survival</th>
<th>Variables associated with non-survival</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septicaemia (65)</td>
<td>Ability to stand at admission, RR ≥60 breaths/min, normal mucous membranes; Neutrophils ≥4000/μl, glucose ≥120 mg/dl, pH ≥7.35</td>
<td>Induced delivery, &gt;24 h duration of clinical signs prior to referral</td>
<td>Gayle et al. 1998</td>
</tr>
<tr>
<td>Bacteraemia (423)</td>
<td>Younger age at admission, elevated temperature and neutrophil count</td>
<td>Septic arthritis, increased band neutrophils, elevated creatinine</td>
<td>Sanchez et al. 2008</td>
</tr>
<tr>
<td>NICU foals &lt;7 days of age (1073)</td>
<td>Presence of suckle, ability to stand at admission, WBC ≥7400/μl</td>
<td>Elevated creatinine and anion gap, dystocia, caesarean section</td>
<td>Rohrback et al. 2006</td>
</tr>
<tr>
<td>Septic arthritis (93)</td>
<td>Pneumonia, severe depression, septic arthritis</td>
<td>Isolation of Salmonella spp. from synovial fluid, presence of multisystemic disease</td>
<td>Raisis et al. 1996, Steele et al. 1999</td>
</tr>
<tr>
<td>Septic osteomyelitis (108)</td>
<td>Confirmed or suspected placentalis, spontaneous delivery, suckle present; NL &gt;10, elevated WBC and fibrinogen</td>
<td>&lt;30 days of age at diagnosis, critically ill, multiple joints and/or bones affected Induction, dystocia, NL &gt;2.0, pH &lt;7.3, decreased body temperature</td>
<td>Neil et al. 2010</td>
</tr>
<tr>
<td>Prematurity</td>
<td></td>
<td>Koterba 1990, Smith et al. 2004</td>
<td></td>
</tr>
</tbody>
</table>
NOTES


References


Saturday 11th September 2010

survivors were described as 'useful, athletic adults'. Early survival rates for septic foals approached 25% (Koterba et al. 1984). More recent studies report short-term survival rates for septic foals between 45–71% (Raisis et al. 1996; Gayle et al. 1998). Discharge rates for NICU foals in general have reached >80% for some NICUs (Axon et al. 1999). Some variables associated with short-term survival/nonsurvival are listed in Table 1.

Studies examining long-term outcomes reported that foals suffering from septic polyarthritis, severe incomplete tarsal bone ossification, advanced prematurity, severe hypoxic encephalopathy or those undergoing abdominal surgery were less likely to race or have fewer starts and earned less money than unaffected age-matched controls (Axon et al. 1999; Dutton et al. 1999; Santschi et al. 1999; Smith et al. 2004; Sanchez et al. 2008). Other studies suggest that while many NICU graduates may be less likely to race than their siblings, if they do race they often perform as well as or better than their unaffected peers (Bryant et al. 1994).

In the final analysis, it is our client who decides whether intensive care was ‘worth it’, a fact that emphasizes the need for frequent and open communication between clinician and owner to discuss available treatment options, possible complications and anticipated outcomes and expenses. Even modest intensive care offered early enough in the course of disease can be surprisingly successful and affordable.


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Cardiopulmonary cerebral resuscitation (CPCR) in foals may be required immediately after birth or in critically ill foals in which arrest occurs due to advanced systemic diseases. Cardiopulmonary arrest in foals, in contrast to adult human patients, is most commonly associated with hypoxia and respiratory arrest which often precedes bradycardia and ultimately cardiac arrest (Corley and Axon 2005; Palmer 2007). While foals requiring resuscitation immediately following birth are often rewarding candidates for CPCR, the prognosis for foals arresting due to progression of a systemic disease process is frequently poor to grave, particularly if the underlying pathophysiological derangement cannot be corrected quickly. Cardiopulmonary cerebral resuscitation has most chance of success if the clinician is anticipating the situation and has prepared for such occasions in advance. Preparations for CPCR should, therefore, be made whenever it is conceivable that an arrest may occur. Examples include any attended foaling but particularly foaling of mares with known risk factors (for example placentitis), critically ill foals with deteriorating conditions or the announcement of the arrival of a dystocia or a severely compromised foal at the hospital. All potentially needed equipment and drugs should be gathered centrally within close range and tasks should be divided between all available staff beforehand, according to individual experience and competency. Regular CPCR exercise which goes step-by-step through the anticipated events at the beginning of each foaling season can serve as a reminder for essential personnel involved.

**Equipment needed for resuscitation of the foal**

- Towels (for birth resuscitation)
- Endotracheal tubes (several sizes: 7–12 mm internal diameter; 55 cm length)
- Syringe (5 ml) to inflate endotracheal tube cuff
- Self-inflating resuscitation bag (Ambu bag)
- Stethoscope
- Adrenalin 1:1000 (1 mg/ml) and/or vasopressin
- Several sizes of syringes and needles
- 14 gauge and 16 gauge intravenous catheters
- Clippers
- +/- Oxygen
- +/- Indirect blood pressure monitoring
- +/- ECG monitor
- Euthanasia solution

**Birth resuscitation**

The vast majority of cardiopulmonary arrests in newly born infants and foals are associated with asphyxia (Corley and Axon 2005; Manole et al. 2009). During deliveries via caesarean section, the effects of anaesthetics administered to the mare on the foal also need to be taken into consideration. During routine foaling where no complications are expected, the foal is initially observed for 30 s. Regular breathing should begin within 30 s and the foal should develop a righting reflex within 5 min (Corley and Axon 2005). If a quick assessment of the heart rate reveals a strong regular heart rate >70 beats/min, no further intervention may be necessary. However, if a foal is delivered following a prolonged stage 2 (>60 min) or during a dystocia or caesarean section, intervention should be initiated sooner rather than later. If a foal is born under these circumstances, the airways are cleared as soon as the foal is delivered and the foal is vigorously dried with towels to stimulate breathing. If multiple people and the necessary equipment are available (in-hospital resuscitations), the foal can immediately be connected to an ECG while airways and breathing are assessed to allow at least initially easy visual control of heart rate and rhythm while resuscitation is initiated. If spontaneous breathing is present and the heart rate is >60 beats/min or increasing, the foal is closely observed without further intervention. If spontaneous breathing is absent and/or the heart rate is <60 beats/min, the foal should be intubated and ventilated for 30 s using either room air or up to 100% inspired oxygen (FiO₂). There is conflicting evidence in human neonatal medicine whether room air or 100% FiO₂ should be used for initial resuscitation as oxygen toxicity is a concern, particularly with use of 100% FiO₂ (AHA 2005; Rajani et al. 2009). Ventilation rates of 10–20 breaths/min have been suggested for foals (Corley and Axon 2005). Higher rates have been associated with decreased coronary perfusion and decreased success rates of CPCR in other species (Plunkett and McMichael 2008). Doxapram to stimulate central respiration is considered contraindicated due to its detrimental effects on cerebral blood flow and an increase in cerebral oxygen consumption (Roll and Horsch 2004; Dani et al. 2006; Plunkett and McMichael 2008). After 30 s, the heart rate is re-evaluated. If the heart rate is increasing or >60 beats/min, ventilation is continued while a decreasing heart rate or a rate of <40 beats/min indicate the need for thoracic compressions; rates of 80–120 compressions/min may be appropriate for neonatal foals (Corley and Axon 2005). Thoracic compressions should not be interrupted for other procedures as any cessation of compressions has been associated with an increase in mortality in human patients (AHA 2005). Should the heart rate remain low despite thoracic compressions and ventilation for further 30 s, adrenalin (1:1000; 1 mg/ml) should be administered at 0.01–0.02 mg/kg bwt i.v. or 0.1–0.2 mg/kg bwt intratracheally (Corley and Axon 2005). Vasopressin (0.2–0.8 μg/kg bwt i.v.) has been suggested as an alternative to repeated doses of adrenalin in human and small animal CPCR and may be used in foals (Corley and Axon 2005; Plunkett and McMichael 2008). Should spontaneous circulation not occur, repeated administration at 3 min interval can be attempted and the adrenalin dose can be increased to 0.1–0.2 mg/kg bwt i.v. (Palmer 2007). If no signs of life are noted after 10–15 min of adequate resuscitation efforts discontinuation of CPCR is probably justified (AHA 2005).
Post resuscitation phase
As soon as the foal’s condition has stabilised, the neonate should be moved to a place where intensive care can be delivered. Patients recovering from CPCR are extremely vulnerable and repeated arrest remains a significant concern within the first 24–48 h. Close attention should also be directed towards peripheral perfusion and blood pressure, pulmonary function and temperature, blood glucose, electrolyte and acid base homoeostasis.

Birth resuscitation of the neonatal foal

References
Neonatal isoerythrolysis
Neonatal isoerythrolysis (NI) is the immune mediated destruction of the foal’s red cells based on differences of the inherited structure of fetal and maternal erythrocytes. The fetus inherits factors from the sire absent in the mare. As there is no transplacental transfer of antibodies in the horse, it depends on ingestion and absorption of anti red cell antigens via the colostrum. Ninety percent of cases of NI are associated with Aa and Qa red cell antigens. Aa is the most antigenic producing the peracute form of the disease.

Other antigens associated with NI include:
- R and S
- Pa
- Ab
- Db
- Ua
- Qc

The frequency of iso-immunisation is much lower than that of incompatible pregnancies, the mechanism for this difference is unknown.

Mules have a high risk factor for developing the disease.

Clinical signs
- Speed onset and severity depends on antigen and quantity antibody passively transferred
- Usually present 12–48 h post partum
- Leathargic, yawning, off suck
- Tachycardia and tachypnoea
- Pale/jaundiced mucus membranes
- Haemoglobinuria
- Collapse
- Neurological signs associated with kernicterus/liver failure

Diagnosis
Diagnosis is based on clinical signs, history and laboratory results.
- Multiparous mare
- Rbc <4 x 10^12/l
- Hb <7 g/dl
- PCV <0.20/l
- Evidence of haemolysis and supernatant plasma will appear yellow
- Coomb’s test positive
- Minor cross match positive for haemolysis and agglutination
- Raised bilirubin levels

Treatment
Treatment is dependant on the severity of clinical signs and of the anaemia.
- Monitor red cell parameters twice daily
- Reduce stress
- Rest
- Supportive care, nursing, adequate nutrition

When to transfuse
Early and rapid development of clinical signs is likely to necessitate early transfusion, whereas with a slow fall in red cells the foal is better able to adapt.

Clinical deterioration of foal
- Rapidly falling Rbc parameters
- PCV >12 l/l and Rbc <3.5 x 10^12/m
- Serial lactate measurements, levels >3.5 mmol/l indicate significant tissue hypoxia

The volume of red cells required can be calculated:

\[
\text{Volume} = \frac{\text{Bwt (kg)} \times \text{Bld vol.} \times \text{PCV desired} - \text{PCV observed}}{\text{PCV of donor}}
\]

Foal’s circulating volume (approx. 7.5% bwt) is limiting, usually 1–2 l by SLOW infusion.

A donor can either be a cross matched gelding or 3 times washed dams red cells.

Transfused red cells have a short half-life in the foal’s circulation, and red cell parameters should continue to be monitored for several days. Repeat transfusions may be required and risk of nonsurvival increases with transfusions >4 l.

Polymerised bovine haemoglobin can be used in an emergency. Doses of 5mg/kg bwt will produce a short-lived clinical effect.

Broad spectrum antibiotic cover is recommended.

Kernicterus, liver failure and sepsis are the most common complications resulting in mortality.

Prevention

Prefoaling
- Identify mare and stallion blood groups
- Detection of anti-erythrocyte antibodies 2–3 weeks prior to foaling

Post foaling
- A jaundiced foal agglutination test can be performed PRIOR to letting the foal suckle the dam
- Muzzle the foal prior to standing
- Administer minimum 500 ml donor colostrum
- Feed colostrum/milk replacer (500 ml/h for 55 kg foal)
- Strip mare’s udder frequently and discard
- Monitor IgG levels. Refractometer levels consistently <10%
- Usually after 18–24 h can allow foal to suckle mare

Ulcerative dermatitis, thrombocytopenia and neutropenia
Rare transient condition seen in foals under 4 days of age which is associated with the absorption of colostral antibodies (Perkins et al. 2005).

The foals present with oral and lingual ulceration, crusty skin lesions around the muzzle, eyes, perineum, trunk and axilla. They have a severe thrombocytopenia, moderate leucopenia.

Diagnosis is based on clinical signs and clinical pathology. Foals usually make an uneventful recovery with supportive care. In some case the use of blood transfusions has been reported. Can recur in subsequent pregnancies even with different sire.
Severe combined immunodeficiency
Most frequently seen in Arabs, this autosomally recessive trait results in failure to produce functional B and T lymphocytes. Affected foals are normal at birth, then suffer from recurrent severe infections, often respiratory, within the first few months of life and usually die by 6 months.

Diagnosis
- History and breed
- Persistent lymphopenia
- Absence of IgM either presuckle or after passively derived levels have fallen.
- Genetic testing available at Animal Health Trust

Post mortem
- Lymphoid hypoplasia of thymus, spleen and lymph nodes

Foal immunodeficiency syndrome (FIS, Fell Pony syndrome)
This recently reported condition due to autosomally recessive trait resulting in deficiency in cellular immunity and nonregenerative anaemia.
- Foals are born healthy
- Show signs recurrent infection after first few weeks
- Common signs include diarrhoea, respiratory disease
- Failure to thrive and poor coat
- Pale mucous membranes/severe anaemia

Diagnosis
DNA test available at AHT from hair samples for affected and carrier animals.

References and further reading
Provision of adequate nutrition is probably the most important part when caring for an orphaned foal. Basic options include finding a nurse mare for the foal or, if that is not possible, to hand-rear the orphan. Apart from being the most natural, convenient and least labour intensive option, a foster mare also allows the foal to grow up in a natural environment which encourages socialisation and provides essential education. The National Foaling Bank http://www.nationalfoalingbank.com/ is an invaluable source when trying to find a foster mare for an orphaned foal. Should a foster mare not be available or an orphan is repeatedly rejected, the foal needs to be hand-reared. Great care should be taken that the foal still has sufficient contact with other horses to allow development of normal social behaviour. In any orphaned foal it is also essential to provide an alternative source for adequate transfer of passive immunity, either in form of high quality colostrums (at least 2 l within the first 6–8 h of life) or commercial hyperimmune plasma administered intravenously. The best nutritional source for a foal is mare’s milk. Milk from other species tends to have a higher fat and protein content compared to mare’s milk which is rich in lactose but has a comparatively low protein and fat content. Mid-lactation mare’s milk contains approximately 10% dry matter, 1.9% protein, 1.3% fat, 6.9% lactose and 506 kcal/l (2115 kJ/l) (Oftedal et al. 1983). A healthy, active, growing foal consumes approximately 100–180 kcal/kg bwt/day and 7.2 g/kg bwt/day of crude protein which equals approximately 20–30% of their bodyweight in milk (Paradis 2003). Milk from other species can be used instead of mare’s milk. Donkey’s milk is very similar to horse milk in regards to its nutritional contents but probably rarely available. Cow’s and goat’s milk has been used successfully to raise orphaned foals. Goat’s milk is more readily consumed by foals than cow’s milk and appears to be tolerated well even when fed unmodified. Due to the higher fat content of cow’s milk, use of skimmed milk (2% fat) with the addition of 20 g/l of dextrose to increase the carbohydrate content has been recommended (Buechner-Maxwell 2005). Several milk replacers are available for neonatal foals should mare’s milk not be available. Most commercial milk replacers designed for foals mimic the composition of mare’s milk more or less closely while milk replacers designed for use in multiple species often contain equal amounts of fat and protein and may therefore be less ideal for feeding of foals. The primary carbohydrate in milk is lactose and poor tolerance of other carbohydrate sources, most likely due to low enzymatic activities of maltase and sucrase in the foal’s small intestine, has been observed (Buffington et al. 1992). Although foals nursing their dams may initially gain weight more readily during the first 2 weeks of life compared to foals consuming milk replacer, no differences between weight gain and muscular development could be identified at 4 months of age between groups (Cymbaluk et al. 1993). It may be easier to initially feed the newborn foal from a bottle; however, bucket feeding is quickly learned by most foals and far less labour intensive. Neonatal foals nurse up to 5 times per hour. Ideally, the neonatal foal should be fed as frequently as possible and feeding every 1–2 h for the first 1–3 days of life has been suggested. The feeding intervals can then gradually be increased to-feedings every 3–6 h. Foals begin to consume solid feed at approximately 2 weeks of age and can be weaned at 16–24 weeks of age although earlier weaning may be possible (Buechner-Maxwell 2005).

References and further reading


Diagnosing and treating colic in the neonate

Sarah Stoneham
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Introduction
A foal with abdominal pain presents a diagnostic challenge to the clinician, differentiating between pending enteritis and an abdominal crisis can be difficult for even the most experienced clinician. Some of the techniques we rely on in the adult are inappropriate in the foal. Pain response is a less reliable indicator in the foal. The physiological differences between adults and foals present additional issues when managing these cases.

Investigating a foal with colic

History
This should include history of pregnancy, parturition, adaptation of the foal and whether there are any infectious disease problems on the premises. Age of onset of clinical signs can also provide useful clues.

Clinical examination
Invaluable to spend a few minutes observing the foal undisturbed when the foal’s demeanour, suckling pattern, pain response and interaction with the mare can be assessed.

This should be followed by a thorough, systematic clinical examination.

Passage of a nasogastric tube
Gastric reflux indicates a physical or functional obstruction and gastric decompression provides significant pain relief in foals with gastric distension. Refluxing neonatal foals with significant gastric distension can be difficult and patience is required to pass through the cardia.

Ultrasound examination
Ultrasonography is a vital part of a colic work-up in the foal, the technique has been well described (Reef 1998; Porter and Ramirez 2005). Where possible, the author prefers to scan the foal while standing, if this is not possible it is important to evaluate both sides of the abdomen. A 5–7.5 MHz rectal probe can be used to provide an evaluation of the abdomen.

Clinical pathology
Blood samples should be taken for haematology, proteins including IgG, electrolyte levels and biochemistry.

Abdominocentesis
Should only be carried out under ultrasound guidance when free abdominal fluid is visualised as due to the thin body wall the intestine is easily lacerated. The use of a teat cannula is less likely to damage the bowel than a needle.

Radiography
Views of the standing foal and in left and right lateral recumbency can help provide information on the site of bowel distension/obstruction. Contrast radiography can be used to localise an obstruction. Interpretation of the radiographs requires experience.

Gastroscopy
Useful to confirm gastric ulceration and monitor response to therapy. Care must be taken with interpretation of findings, as epithelial desquamation is a normal finding.

Some of the conditions that can cause colic in the foal

<table>
<thead>
<tr>
<th>Age group</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonate</td>
<td>Meconium retention</td>
</tr>
<tr>
<td>(&lt;7 days)</td>
<td>Ruptured bladder</td>
</tr>
<tr>
<td></td>
<td>Ileus, sepsis, perinatal asphyxia syndrome, prematurity</td>
</tr>
<tr>
<td></td>
<td>Diarrhoea: anoxic insult, sepsis</td>
</tr>
<tr>
<td></td>
<td>Clostridial enteritis</td>
</tr>
<tr>
<td></td>
<td>Congenital defect e.g. atresia coli</td>
</tr>
<tr>
<td>Any age</td>
<td>Enterocolitis</td>
</tr>
<tr>
<td></td>
<td>Abdominal crisis-volvulus, intussusception</td>
</tr>
<tr>
<td></td>
<td>Gastroduodenal ulceration</td>
</tr>
<tr>
<td></td>
<td>Peritonitis</td>
</tr>
<tr>
<td></td>
<td>Ileus</td>
</tr>
</tbody>
</table>

Treatment
It is important to attend to the immediate needs of the foal as well as instituting specific problem-related therapy as neonatal foals are less metabolically stable than older individuals. The provision of appropriate analgesia and supportive therapy while carrying out a complete work-up is recommended.

Fluid and electrolytes
It is important to institute fluid therapy early, as a neonatal foal that has been off suck for a few hours will rapidly become hypovolaemic, which will result in further complications and increase the risk of drug side effects. Diarrhoea or pooling of fluid in the bowel or abdomen will compound the problem and can produce significant electrolyte imbalance.

Ideally fluid and electrolyte therapy should be based on laboratory results, however these are frequently not rapidly available. Hypoproteinaemia, hypokalaemia, hyponatraemia and hypo- or hyperchloraemia are relative common problems. In the absence of laboratory results the use of lactated Ringers’ solution spiked with 20 ml of 50% glucose per 1 l bag is recommended, the exception to this is when uroperitoneum is suspected.

Sodium bicarbonate should be used with extreme caution as metabolic acidosis is most commonly due to poor tissue perfusion and is corrected by fluid resuscitation.

Fluid therapy needs to be considered in 2 parts as resuscitation and then maintenance in the neonate.

It may be appropriate to correct fluid and electrolyte disturbances enterally with oral electrolyte solutions and specific electrolyte supplementation. Care should be taken with the content of these solutions as in young foals, that are not suckling or drinking water and have poorly established homoeostatic mechanism, further imbalances can be induced.

Analgesia
It is important to provide adequate pain relief to young foals. Care is needed with the choice of drug in neonatal foals, as the risk of side effects such as compromised renal function and alterations in gastric blood flow can be significant. In the author’s experience
butorphanol (0.01–0.04 mg/kg bwt) is useful in most instances; however, it does produce some degree of sedation. Buscopan Compositum (0.3 mg/kg bwt hyoscine butylbromide, Boehringer Ingelheim) is another useful agent when used with care. NSAIDs should be used with caution due to their effects on renal function and alterations in gastric blood flow.

**Feeding vs. gastrointestinal rest**

Ileus and gastrointestinal distension require gastrointestinal rest. The foal can be muzzled or separated from the mare by a partition. If milk is withheld the foal should be given fluids and glucose i.v. to maintain hydration and blood glucose levels. If gastrointestinal rest for more than 24 h is necessary, parenteral nutrition should be instituted early in the course of the condition. A period of 12 h gastrointestinal rest and i.v. fluids may be helpful in cases of severe or intractable diarrhoea. When milk is reintroduced this should be done gradually.

**Treat primary problem**

The treatment of some of the more common problems will be discussed.

**Further reading**


Liver disease in horses is often a diagnostic challenge and, as a result, can also be a therapeutic challenge. Because clinical signs of liver failure are typically not seen until 80% or more of the hepatic mass is affected, disease is often advanced and may be irreversible by the time a diagnosis is made.

**Diagnosis**

As a result of the liver’s many functions, a diverse range of clinical signs (Table 1) can be seen with liver disease, none of which are pathognomonic. Biochemical testing can be used to further localise the cause of the signs to the liver (Table 2). Some of these tests are ‘liver specific’; however, beyond determining whether the abnormality is associated more with hepatocyte damage (increased SDH, AST) than cholestasis (increased GGT), a specific diagnosis cannot be made using blood work alone. As a result, further diagnostic testing will typically be required to help define the aetiology of the liver dysfunction, unless the history is strongly suggestive of a diagnosis (such as grazing Ragwort-infested pastures).

Ultrasound examination of the liver is the logical next step, although in many cases this will be normal. Ultrasound is most useful in diagnosing hepatic masses or abscesses, changes in echogenicity that may suggest a cellular infiltrate, for identifying choleliths and biliary stasis and for locating an appropriate biopsy site. Because of the location of the liver, being mostly ‘hidden’ behind the lungs, only approximately 20% of the organ can be imaged and, as a result, focal diseases may be missed.

Histopathological evaluation of liver biopsy specimens is considered the most direct way to diagnose disease in and formulate a prognosis for horses with liver disease. The technique is generally considered safe, although prebiopsy evaluation of coagulation may be appropriate in horses with signs suggestive of hepatic failure. Although a biopsy may provide a definitive diagnosis in some cases, such as pyrrolizidine alkaloid toxicity, in other cases the changes identified are nonspecific. Hypoxia, toxins, infectious agents, immunological events and severe metabolic disorders may all result in parenchymal destruction. In response, hepatic regeneration, fibrosis and biliary hyperplasia may all occur to varying degrees. Interpretation of biopsy specimens should be made in conjunction with clinical signs, other diagnostic findings and response to therapy. Marked fibrosis, especially bridging fibrosis, carries a poor prognosis, regardless of the initiating cause.

**Treatment**

**Hepatic encephalopathy**

Although typically the result of irreversible liver disease (either acute or chronic), HE is in itself a potentially reversible syndrome. Treatment therefore may be warranted while awaiting diagnostic tests or assessing response to therapy. If sedation is required, small doses of xylazine or detomidine should be used because of the liver’s decreased ability to metabolise these agents. Cerebral oedema can occur and rapid improvement in demeanour may be observed following treatment with mannitol or hypertonic saline. Lactulose, which acts to ‘trap’ ammonia within the GIT as ammonium and therefore minimise ammonia absorption should be considered the most direct way to diagnose disease in and formulate a prognosis for horses with liver disease. The technique is generally considered safe, although prebiopsy evaluation of coagulation may be appropriate in horses with signs suggestive of hepatic failure. Although a biopsy may provide a definitive diagnosis in some cases, such as pyrrolizidine alkaloid toxicity, in other cases the changes identified are nonspecific. Hypoxia, toxins, infectious agents, immunological events and severe metabolic disorders may all result in parenchymal destruction. In response, hepatic regeneration, fibrosis and biliary hyperplasia may all occur to varying degrees. Interpretation of biopsy specimens should be made in conjunction with clinical signs, other diagnostic findings and response to therapy. Marked fibrosis, especially bridging fibrosis, carries a poor prognosis, regardless of the initiating cause.

**Table 1: Clinical signs of liver disease**

<table>
<thead>
<tr>
<th>Common signs</th>
<th>Less common signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td></td>
</tr>
<tr>
<td>Anorexia</td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td></td>
</tr>
<tr>
<td>Hepatic encephalopathy</td>
<td></td>
</tr>
<tr>
<td>Weight loss</td>
<td></td>
</tr>
<tr>
<td>Icterus</td>
<td></td>
</tr>
<tr>
<td>Icterus</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Blood work changes in liver disease**

<table>
<thead>
<tr>
<th>Test</th>
<th>Liver specific</th>
<th>Other sources</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilirubin (↑)</td>
<td>X</td>
<td>Haemolysis</td>
<td>Increased with anorexia</td>
</tr>
<tr>
<td>Bile acids (↑)</td>
<td></td>
<td></td>
<td>Increased with anorexia (3 days+)</td>
</tr>
<tr>
<td>Albumin (↓)</td>
<td>X</td>
<td>Protein loss through GIT, kidneys etc.</td>
<td>Rare - long half life</td>
</tr>
<tr>
<td>Globulins (↑)</td>
<td>X</td>
<td>Inflammation</td>
<td>Decreased Kupffer cell mass results in increased dissemination of enteric derived antigens → polyglonal gammopathy</td>
</tr>
<tr>
<td>Clotting times (↑)</td>
<td>X</td>
<td>Many - e.g. DIC</td>
<td>Rarely see clinical signs</td>
</tr>
<tr>
<td>Glucose (↑)</td>
<td>X</td>
<td></td>
<td>Rare</td>
</tr>
<tr>
<td>Tg (↑)</td>
<td>X</td>
<td>Systemic disease resulting in anorexia</td>
<td>Marked increases can result in hepatic lipidosis</td>
</tr>
<tr>
<td>SDH (↑)</td>
<td>X</td>
<td>Skeletal muscle</td>
<td>Acute liver disease - short half life</td>
</tr>
<tr>
<td>AST (↑)</td>
<td>X</td>
<td>Bone, intestine, placenta, kidney, leucocytes</td>
<td>Long half life</td>
</tr>
<tr>
<td>ALP (↑)</td>
<td>X</td>
<td></td>
<td>Increased activity in normal foals, during pregnancy, by haemolysis, with GIT disease</td>
</tr>
<tr>
<td>γ-glutamyl transferase (↑)</td>
<td>Yes</td>
<td>Kidney - excreted into urine, not in blood</td>
<td>Cholestasis</td>
</tr>
</tbody>
</table>

**Table 1**

**Table 2**

**Abdominal Disease**

Chaired by Catherine McGowan

09.00–09.30

**Diagnosis and practical treatment of hepatic disease**

Imogen Johns

Equine Referral Hospital, Royal Veterinary College, Hawkshead Lane, North Mymms, Hertfordshire AL9 7TA, UK.

**Table 2**
be given in acute cases and can also be used for long-term management. Diarrhoea can occur, although appears to be rare. Dietary modification is considered essential in the long-term management of these horses.

**Antibiotics**

In some cases of liver disease, antibiotics are clearly indicated. Fever, blood work suggestive of infection and/or predominantly neutrophilic infiltration in biopsy specimens suggest a bacterial aetiology. Cholangitis or cholangiohepatitis are thought to result from ascending infection from the GIT and enteric organisms may be cultured from the liver. If a positive culture is obtained, antibiotic treatment should be based on sensitivity results. However, in the majority of cases, a negative culture is obtained, and empirical treatment must be implemented. Broad-spectrum coverage with penicillin/gentamicin/metronidazole or a cephalosporin is appropriate for short-term treatment, followed by long-term treatment with oral TMPS or doxycycline. Treatment should be continued until resolution of clinical signs and normalisation of blood work. In one study, a median of 51 days of treatment was required for horses with cholangiohepatitis.

In other cases, the need for antibiotic treatment is not clear cut. The presence of neutrophils on a biopsy specimen is suggestive of a bacterial aetiology, although is not pathognomonic. In many cases, a therapeutic trial of antibiotics (± corticosteroids) is used in horses with nonspecific signs of liver disease without a definitive biopsy diagnosis. TMPS is a logical choice in these situations, because of price and ease of administration, although it has been suggested that there is widespread resistance in enteric bacteria to the drug.

**Corticosteroids**

Prednisolone (1 mg/kg bwt per os, tapering over several weeks) is used as an anti-inflammatory and with the hope of preventing progression of fibrosis. The indications for using steroids are not clear cut, but there does appear to be a subset of horses with evidence of both chronic and active inflammation on biopsy that respond to prednisolone. Other anti-fibrotic agents, such as pentoxyfilline, have also been used in horses.

**Milk Thistle**

Although lacking in horses, there is sufficient evidence in other species to suggest that Milk Thistle (silymarin) is beneficial in the treatment of liver disease. Milk Thistle is believed to act as an anti-oxidant and free radical scavenger and may retard fibrosis formation.

**Vitamin E**

Vitamin E levels may be decreased with liver disease (especially cholestasis) and supplementation may normalise levels and decrease hepatic oxidant injury.

**S-adenosylmethionine (SAMe)**

SAMe is a naturally occurring molecule that is synthesised in all living cells and is an essential in intermediary metabolism, as it is both an anti-inflammatory and anti-oxidant. A dose of 5 g per os s.i.d. has been suggested for horses, although evidence for its efficacy/bioavailability in horses is lacking.

**Nutrition**

Inappetant horses should be tempted with a variety of feedstuffs until their appetite returns. In horses with HE or for longer term management, dietary modification to provide a diet without excessive protein and in which the ratio of BCAA:AAA is optimised should be fed. This will minimise the nitrogenous substrates for ammonia production by enteric bacteria and minimise AAA entry into the brain (where they can contribute to HE by acting as precursors for the inhibitory neurotransmitter serotonin as well as for false neurotransmitters). Beet pulp, corn, oats and sorghum can form the mainstay of these diets. Grass hays rather than alfalfa should be used to provide roughage.
Diagnosis and practical treatment of renal disease

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Introduction
Although less common in horses compared to other conventional veterinary species, renal disease can present significant challenges clinically, particularly from the perspective of early diagnosis and effective treatment options. Similar to hepatic disease, the functional reserve of the kidneys allows for compensation to a degree that means that advanced bilateral disease is often present before outward evidence of organ dysfunction becomes obvious to the owner. Some of the early and gradual signs of worsening renal function may be missed by all but the more attentive owners until such time that weight loss or other more specific urinary signs are appreciated. By that time poorly correctable organ compromise or even failure may already be present. Mature horses may experience a variety of infectious, inflammatory, immune-mediated, obstructive and rarely neoplastic renal diseases. However, clinical experience suggests that many cases of acute renal disease in adults fall into the categories of toxic or vasomotor damage, with the latter being a known risk in horses with concurrent or antecedent dehydration and endotoxaemia associated with systemic inflammatory responses secondary to gastrointestinal disease. The 2 types of drugs that are most commonly associated with nephrotoxicity are the aminoglycosides and the nonsteroidal anti-inflammatory drugs (NSAIDs). On occasion tetracycline administration may also cause acute tubular damage. Pigment nephropathy from severe acute myoglobin release during myopathy or repeated chronic insult in an individual with chronic muscle damage is another important cause of renal disease. Haemoglobin release during haemolytic crises is a potential but less common cause of pigment induced renal injury. Chronic interstitial nephritis and chronic glomerulonephritis are the 2 most common forms of chronic renal disease encountered in adults, the aetopathogenesis of both being poorly elucidated at this time. Some cases of chronic interstitial disease represent progression of acute, subacute or repetitive tubular damage due to infection or toxicity but many seem to appear spontaneously. Chronic glomerular disease may be autoimmune in origin.

Renal disease in foals is also commonly vasomotor or toxic in origin, although a combination of hypoperfusion and septic insult is frequently to blame for renal failure in critically ill neonates. Congenital renal disease is quite rare in horses, but should be ruled out in cases of older foals or young adults that present with renal failure with none of the obvious risk factors mentioned above. Ultrasound can be particularly useful for structural, congenital anomalies.

Diagnosis of renal disease
There are very few instances where anamnesis and physical examination findings are pathognomonic for acute or chronic renal disease. Polyuria, polydipsia and abnormal urinary behaviour are not always specific for urinary tract disease let alone primary renal disease. The majority of cases of acute (ARF) or chronic renal failure (CRF) demonstrate the nonspecific clinical findings of variable depression, partial to complete anorexia and weight loss and it is only following biochemical analysis that kidney disease is revealed. Azotaemia that is confirmed to be renal in origin by urinalysis remains the gold standard for the diagnosis of true renal disease. The failure to concentrate urine (SG>1.020) in the face of azotaemia is indicative of renal disease; this may be further confirmed by a fractional excretion of sodium value that is in excess of 1%. Urinalysis is also revealing as to the presence and severity of proteinuria, pigments and casts. Combined massive proteinuria and hypoalbuminaemia in serum should raise suspicion of a primary glomerular condition. Deviations in serum electrolyte values away from normal reference ranges can vary widely between ARF and CRF and are rarely impactful on therapy, unless there are extremes of hypouraemic/ hypernatraemic/chaenoraeic as can occasionally occur with ARF.

Therapy of renal disease
Practically speaking individuals with acute renal disease often represent better candidates than those with chronic disease provided the primary cause can be addressed and there has not been irrevocable nephron loss/damage to greater than 75% of the total renal functional mass. The severity of the azotaemia in ARF patients should not be over interpreted prognostically especially in cases due to toxicity. In either ARF or CRF the clinical response alongside the biochemical improvement in creatinine value noted over 24–96 h of high volume i.v. diuretic fluid therapy (1.5–2 times maintenance values) are the most relevant things to observe. Unfortunately, by the time veterinarians attend to CRF cases, this degree of nephron loss has often already occurred in tubular diseases or, in the case glomerular injury, the severe albumin loss can only be transiently reversed. The 2 most important issues to consider during such high volume fluid therapy acutely are, can the patient make urine effectively? (if not, then aggressive i.v. fluid therapy will lead to volume overload and disaster) and is there sufficient colloid osmotic pressure (if not then peripheral oedema will worsen). Hospital based ancillary diagnostics such as blood pressure monitoring, colloidal oncotic pressure measurement and urine output assessment allow clinicians to better articulate these treatment concerns and hence such cases are better managed in this location. Many cases of ARF have some other primary issue (primary muscle damage, drug or plant toxicity, concurrent GI disease, pleuropernephritis etc.) which will also dictate specific therapy above and beyond diuresis, but the latter is critical in achieving a successful outcome. Those individuals with CRF may benefit from a renal biopsy to better characterise their disease and perhaps indicate other therapy such as corticosteroids in the case of glomerular conditions.

References
Inflammatory bowel disease as a cause of colic: diagnosis and treatment

Andy E. Durham and David Rendle
The Liphook Equine Hospital, Forest Mere, Liphook, Hampshire GU30 7JG, UK.

Introduction
Inflammatory bowel disease (IBD) represents a poorly characterised group of conditions in the horse that may present with colic, weight loss, diarrhoea, oedema and lethargy. The following discussion presents a brief overview of equine IBD and also presents unpublished data gathered from 75 IBD cases diagnosed from full thickness surgical biopsies at The Liphook Equine Hospital between 1999 and 2007.

Subtypes of equine IBD
IBD has generally been categorised according to the predominant inflammatory cell type in the intestinal wall: eosinophilic, lymphocytic-plasmacytic, granulomatous and mixed. Intestinal infiltration by eosinophils may occur in at least 3 different general patterns: firstly, multisystemic eosinophilic epitheliotropic disease (MEED) involving abnormal eosinophilic infiltrates in intestine and other organs such as liver, lung and skin; secondly, diffuse eosinophilic enteritis (DEE) characterised by abnormal eosinophilic infiltrates found diffusely within the wall of small and/or large bowel and thirdly, focal/multifocal eosinophilic enteritis (FEE) characterised by focal nodules or circumferential mural bands of eosinophilic inflammation affecting the small or large bowel.

Of the 75 horses diagnosed with IBD at Liphook between 1999 and 2007, 11 (15%) were diagnosed with lymphocytic-plasmacytic enteritis (LPE); 27 (36%) with mixed lymphocytic-plasmacytic and eosinophilic enteritis (LP/EE); 23 (31%) with DEE and 14 (19%) with FEE.

Signs
Cases of eosinophilic enteritis (DEE or FEE) in the current literature have presented with colic, whereas horses with LPE have presented with weight loss, diarrhoea and colic. In the case series from Liphook, there indeed appeared to be an association between eosinophilic infiltrates and colic (especially acute colic) and between lymphocytic-plasmacytic infiltrates and diarrhoea and weight loss. Nevertheless, colic was still the predominant clinical sign on all IBD subtypes and several horses with eosinophilic infiltrates were affected by weight loss and diarrhoea. All horses with FEE presented with colic, although in 1/14 cases weight loss was also reported.

Diagnosis
The only serum biochemical markers found to be abnormal in more than 50% of cases tested were hypoalbuminaemia (<26 g/l) which was found in 22/39 (56%) horses tested and increased serum amyloid A (>4 mg/l) which was found in 10/14 (71%) horses tested. Other notable findings were increased plasma fibrinogen (>3.7 g/l) which was seen in 10/21 (48%) cases and increased serum alkaline phosphatase which was seen in only 6/24 horses (25%) in which it was measured.

An oral glucose absorption test (OGAT) indicated malabsorption (peak <85% above baseline glucose) in 9/15 (60%) of the cases that were subsequently diagnosed with IBD involving the small intestine. The results of OGAT correlated neither with serum albumin nor degree of intestinal inflammation. Interestingly abnormal OGAT results were identified in one horse that was subsequently found to have FEE of the small intestine.

Intestinal thickening (>4 mm) was identified in 11/20 (55%) cases.

The results of peritoneal fluid analysis were available for 39 horses. An increased total nucleated cell count (>5 x 10⁹/l) was found in only 3/39 (8%) horses. Increased total protein concentration (>20 g/l) in peritoneal fluid was seen in 10/39 (26%) horses. Interestingly increased peritoneal fluid protein was a rare finding in horses with LPE or LP/EE and more common in those with DEE and FEE.

Definitive diagnosis of IBD type necessitates histopathological examination of the affected intestine. Minimally invasive techniques for collection of intestinal biopsies include duodenal mucosal and rectal mucosal biopsy. Intuitively, the diagnostic usefulness of full thickness surgical biopsies is likely to be greater and the cases selected for the Liphook study had all been subject to this procedure. Visible inflammation and palpable thickening were only identified in a minority of cases at surgery demonstrating the importance of histopathological examination in the diagnosis of IBD.

Logically, histopathological diagnosis and classification of IBD depends upon knowledge of normal cell distributions. Attempts to quantify leucocyte populations in normal equine intestine have been published although appear to be rarely referred to. Additionally, significant interindividual variability in cell populations may also lead to misdiagnosis.

Treatment
The most common treatment for equine IBD is prednisolone administered orally (1–2 mg/kg bwt s.i.d.). Lack of response to initial therapy often leads to an increasing dose of prednisolone, a change to oral dexamethasone therapy or parenteral dexamethasone (0.05–0.1 mg/kg bwt q. 24–48 h). The treatment period is rarely less than 3 months and can be as long as 2 years (6–9 months most frequent).

Prognosis
Thirty-four (61%) of the 56 horses for which follow-up data was available were alive at 12 months. The type of inflammatory infiltrate in the intestines of horses in the current study was relevant to the likelihood of survival. Prognosis was good for horses with DEE and LP/EE (approx 70% survival). Previous reports of horses with circumferential mural bands have documented long-term survival rates of 58% (7/12) following resection of the affected intestine (Archer et al. 2006) and 100% (28/28) when the intestine was decompressed but not resected (Perez Olmos et al. 2006). In a previous study, 89% (16/18) of horses with segmental eosinophilic colitis were alive 3–7 months after surgery (Edwards et al. 2000). In previous reports LPE has been associated with a hopeless prognosis (Kemper et al. 2000) in contrast to the Liphook study which found that 6/11 (55%) of LPE cases were still alive 12 months after diagnosis.

Of the horses in all groups which survived, 25% (9/36) continued to suffer at least one episode of colic and 6% (2/36) had other clinical signs of intestinal disease such as weight loss.
or failure to gain weight. Horses with marked intestinal inflammatory infiltrates were no less likely to survive than horses with mild inflammation. In horses with diffuse cellular infiltrates (LPE, LP/EE, DEE) and moderate or marked villous atrophy were less likely to survive than those with mild or no villous atrophy. Villous atrophy was more likely to be present in the FEE (8/12) and LPE (5/11) groups than in the DEE (6/23) and LP/EE (7/27) groups.

References and further reading

Liver biopsy
Liver biopsy in the horse is an important adjunct diagnostic procedure in the evaluation of an individual with biochemical and/or clinical evidence of hepatic dysfunction. Inadvertent penetration of the colon, diaphragm, or even lung can occur when performed blindly using an intersection of a line drawn from the right tuber coxae to the point of the elbow and the 14th intercostal space but this can be avoided with the use of a low to medium frequency (2.5–7 mHz) ultrasound probe to identify liver beneath the lateral body wall in the right 11th through 16th intercostal spaces. In older horses or those with reduced hepatic mass even ultrasound guidance can sometimes fail to identify a ‘safe’ window for biopsy. Occasionally the liver can be visualised and biopsied in the left cranial abdomen, typically in the 9th–11th intercostal spaces and it is worth looking here if the right side does not provide access. It is important to appreciate the echogenic difference between liver and spleen on the left because the 2 organs are often closely aligned.

Light i.v. sedation is typically all that is required for restraint followed by aseptic preparation of the skin. Local skin and body wall infiltration with anaesthetic is appropriate. A biopsy device is then introduced through a stab skin in the skin and subcutis. My preference is for a 14 gauge TruCut biopsy device that is manually operated but automatic biopsy guns that can be even attached to some transducer probes for more precise guidance are also available. Biopsy material should be divided into samples for histopathology and aerobic/anaerobic culture.

Renal biopsy
Renal biopsy is a rarely performed procedure by equine veterinarians, principally because of the historic perception of associated risks and the expense of the procedure. Additionally, renal histopathology will only occasionally provide insightful diagnostic or therapeutically relevant information above and beyond what can be obtained from other less invasive diagnostics. Biopsy is more likely indicated in horses with ultrasonographically detected renal masses compared to those with ultrastructurally normal kidneys but biochemical evidence of acute or chronic tubular or glomerular disease. Most commonly the right kidney is chosen due to its accessibility close to the body wall in the right 17th intercostal space. The left kidney may also be biopsied in some horses but it is typically twice the distance from the body wall of the right kidney, is harder to image and frequently only accessible through the spleen. It is preferable to enter the lateral part of the right kidney having first identified the relevant window in the intercostal space, introducing a 14 gauge Tru-Cut biopsy device manually directed perpendicular to the skin surface to the measured depth of the cortico-medullary junction. Biopsy guns introduced under ultrasound guidance can also be used, as for liver biopsy. There are risks for perirenal/subcapsular haemorrhage and/or renal injury resulting in microscopic or gross haematuria and although these should be discussed with owners it appears from a recent large retrospective study (71 horses) that the complication rate is only about 10%.

Rectal biopsy
The premise of this procedure is that a rectal mucosal sample might histologically reflect the mucosa/submucosa of the more cranial intestinal tract in a horse with malabsorption/maldigestion.

The only specific equipment needed will be a pair of endometrial biopsy forceps in excellent working order. The safety of the procedure, as with any rectally performed diagnostic technique, is dictated by adequate restraint and a patient, calm approach. A sleeved hand is inserted rectally to the level of the mid-upper arm and the rectal mucosa grasped between thumb and forefingers at a 10 o’clock and 2 o’clock position. In young or unpredictable horses instillation of up to 60 ml of local anaesthetic into the rectum may be helpful. With the other free hand the biopsy device is introduced under the palpation hand and the ‘pinned’ rectal tissue placed into the biopsy device. The obtained sample can then be placed into formaldehyde. Only a piece of mucosa will be obtained and the sample therefore provides less information than full thickness biopsies obtained via laparotomy. Prospective studies comparing the accuracy of the procedure with necropsy derived tissue samples in horses with protein losing enteropathies have shown that rectal mucosal biopsy provided a histological diagnosis in about 40–50% of cases. On a rare occasion we have identified encysted cyathostomes within rectal biopsy material. The condition for which I have seen the greatest sensitivity has been alimentary lymphoma.

Further reading
Abdominal ultrasound - using practice based machines

Alex McSloy
The Royal Veterinary College, Hawkshead Lane, North Mymms, Hertfordshire AL9 7TA, UK.

Equipment and scanning technique

KEY: use highest frequency transducer that penetrates to area under investigation and display smallest depth of field necessary. Curved linear transducers combine desirable characteristics of sector and linear transducers - providing wide near and far fields of view. Start with 7.5 MHz transducer at depth 4–8 cm and then 5.0 MHz. Most rectal and tendon probes are 5–7.5 MHz and work well for visualisation of most abdominal structures.

***KEY: Order of echogenicity: Kidney < Liver < Spleen

Liver
Liver parenchyma is homogeneous and of medium echogenicity. Bile ducts are not normally visible, but the portal veins are. Hepatic veins can be traced to the caudal vena cava, although this structure can only be visualised in smaller horses. Estimation of hepatic size in horses is hard and is only relative. In older horses atrophy of the right liver lobe is common making it hard to image any liver in some normal aged animals. Hepatomegaly should be considered if the liver continues beyond the border of the costochondral junctions. The ventral margin of the liver should always appear sharp.

- **Acute hepatitis and hepatocellular necrosis:** Decreased echogenicity and small liver.
- **Chronic hepatic fibrosis:** Increased echogenicity (similar to that of spleen) and a shrunken liver.
- **Cholangiohepatitis:** Markedly enlarged liver with increased echogenicity associated with fibrosis and cellular infiltrate and thickening of bile ducts.
- **Cholelithiasis:** Distension of biliary tree. Parallel channel sign: dilation of bile ducts alongside portal vein. Bile duct proliferation and bile stasis seen. Obstructing stone blocking common bile duct is often large but inaccessible to imaging. Cholelithiasis should be suspected in all horses with bile duct dilation. Smaller multiple heptoliths may be seen as hyperechoic structures casting acoustic shadows.
- **Hepatic lipidosis:** Generalised hepatomegaly. Diffuse increase in echogenicity; ‘bright liver’.
- **Focal ‘cavitatary’ liver disease:** Differential diagnoses: Hydatid cysts, polycystic liver disease, hepatic abscesses.
- **Hepatic neoplasia:** most commonly lymphosarcoma. Diffuse increase in echogenicity, hepatomegaly; rounded margins. Discrete masses have been reported.

Fig 1: Area to be clipped for full abdominal scan.

Fig 2: A: kidney - right kidney lies immediately ventral to transverse processes between 14th and 17th intercostal space (ICS) at level of tuber coxa, left kidney lies further caudal and ventral at the 17th ICS to paralumbar fossa and is medial to spleen; B: liver - right lobe of liver extends from 6th/7th ICS to 14th/15th ICS, left lobe is smaller and extends from 6th to 9th ICS, immediately caudal to diaphragm; C: spleen - extremely variable in size, left abdominal wall from 8th ICS to 17th ICS or paralumbar fossa.
Spleen
Most echogenic and homogeneous organ.
- **Splenectomy**: 37% of lymphosarcoma cases have splenic involvement at post mortem. Marked enlargement is seen, along with masses bulging from the surface.
- **Splenial haematoma**: Lociated anechoic mass; may contain echogenic masses associated with clot formation.
- **Splenomegaly**: almost impossible to reliably diagnose in horse due to wide normal variation.

Kidneys
Remember the transrectal window can also be used. The renal cortex is hypoechoic compared to surrounding tissues, with a mottled appearance, and is 1–2 cm thick. The adjacent medulla is less echogenic than cortex. The renal pelvis is very echogenic due to intrapelvic fat and fibrous tissue.

- **Acute renal failure**: Kidneys are enlarged with parenchyma less echogenic than normal with a thicker cortex. Per-reneal oedema may be seen with oliguria/anuria. Note: an increase in echogenicity is seen with renal insufficiency and iatrogenic drug toxicity.
- **Chronic renal failure**: Kidneys smaller and irregular. Increased echogenicity associated with fibrosis and inflammatory infiltrate. Poor differentiation between cortex and medulla.
- **Nephrolithiasis**: Nephroliths seen as hyperechoic structures casting an acoustic shadow.
- **Hydronephrosis and hydro-ureter**: Marked dilation of renal pelvis; thin renal cortex; irregular contour. Dilated renal calyces may have a cystic appearance. Hydro-ureter seen transrectally, as a thickened wall and diameter 2–3 cm.
- **Pyelonephritis**: Echogenic purulent debris in renal pelvis. Gross enlargement is present with a dilated renal pelvis and renal calyces.
- **Renal masses**: Differential diagnoses include: neoplasia (adenocarcinoma >lymphosarcoma); abscess; haematoma; parasitic granuloma.

Gastro-intestinal visera
The stomach is visualised as a large semicircular echo on the ventral left abdomen at about the 8th to 13th ICS. Wall thickness up to 7.5 mm.

NOTES

**Renal masses:**
- **Pyelonephritis:**
- **Hydronephrosis and hydro-ureter:**
- **Nephrolithiasis:**

**NOTES**

**Splenomegaly**: almost impossible to reliably diagnose in horse due to wide normal variation.

Kidneys
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Gastro-intestinal visera
The stomach is visualised as a large semicircular echo on the ventral left abdomen at about the 8th to 13th ICS. Wall thickness up to 7.5 mm.

Small intestinal peristaltic activity is seen as rhythmic contractions causing lumen to collapse then open as fluid ingesta moves through in a pulsatile manner. Duodenal diameter during distension phase does not exceed 33 ± 6.6 mm. Walls of duodenum and jejunum <3 mm in horses, 1.8 mm in ponies. The ileum is slightly thicker –4–5 mm. The duodenum can be found in a superficial location along the right side of the abdomen on a line from the olecranon to the tuber coxae and jejunum along the ventral and visceral surface of the spleen and dorsal to left dorsal colon.

The large colon and caecum are recognised by their large size and sacculations with wall thickness of 0.3 cm and hyperechoic along the mucosal surface with a ‘rough’ appearance. The small colon has diameter of 7–10 cm but also appears sacculated.
- **Ileus**: Small intestinal loops are distented and rounded in cross section, often >6 cm diameter. A lack of coordinated peristalsis is evident.
- **Nephrosplenic ligament entrapment**: Entrapment of the large colon impairs visualisation of the left kidney. Gas echo seen dorsal to spleen in left paralumbar fossa. Straight horizontal dorsal border of spleen extends cranially and caudally. Ventral displacement of spleen to right of ventral midline. Caution!! Small colon and small intestine can occasionally be visualised between spleen and kidney - incidental finding. The condition is correctly diagnosed ultrasonographically in 88% horses, compared to only 32% on rectal examination.
- **Enteritis**: Fluid-filled hypermotile small and/or large intestine. Wall thickness increased: symmetric, extensive and oedematous in appearance.
- **Anterior enteritis**: Fluid-filled hypomotile small intestine with gastric distension.
- **Inflammatory bowel disease**: Thickened oedematous small intestinal wall, up to 5 cm thick. Mesenteric lymph node enlargement.

Peritoneal cavity
Peritoneal fluid may not be visualised at all, or only a small amount ventrally and should be anechoic.
- **Peritonitis**: determine quantitty and character of peritoneal fluid. Fibrin tags, fibrous loculations, cellular debris and adhesions may be seen.
Thoracic ultrasound in horses

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Ultrasonographic examination of the thorax can provide useful information regarding pathology of the pleural cavity, the pleural surfaces, as well as the superficial pulmonary parenchyma.

The normal anatomy
The thoracic cavity of the horse extends from approximately the 5th to the 16/17th intercostal spaces. The mediastinum separates the 2 pleural cavities. The pleural cavities are lined by the visceral (lung surface) and parietal (rib/intercostal surface) pleura. The mediastinum between the 2 pleural cavities is typically fenestrated (incomplete) in horses.

Indications for and limitations of pulmonary ultrasound
Pulmonary ultrasound can be used to investigate the aetiology of many respiratory disorders in horses and foals. Because the ultrasound beam will be reflected by air, it is most useful when there are pleural disorders or pulmonary pathology at the lung periphery. Pulmonary pathology that is deep to normally aerated lung will not be visualised via ultrasonography. As such, it is often useful to combine both pulmonary ultrasonography and thoracic radiographs to investigate suspected thoracic disorders.

Transducers (probes)
The choice of transducer will vary depending on the depth/penetration required, and the detail desired.

<table>
<thead>
<tr>
<th>Depth required (cm)</th>
<th>Transducer</th>
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<tbody>
<tr>
<td>4–8</td>
<td>7.5–14 MHz</td>
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<tr>
<td>8–15</td>
<td>5–8 MHz</td>
</tr>
<tr>
<td>20+</td>
<td>3–3.5 MHz</td>
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Normal ultrasonographic appearance
With the transducer positioned between the ribs, the skin and intercostal musculature are imaged as the most superficial structures. The pleura are not normally visualised, as they are extremely thin membranes. The pleural space is also not normally visualised, as it remains a potential space unless it is filled with fluid or masses. The lung is seen as a bright white hyperechoic line, which represents the reflection of the ultrasound beam at the visceral pleural surface. The beam does not penetrate into normally aerated lung. The lung surface will move in a dorso-ventral direction with respiration in a smooth, gliding motion. When the lung is normally aerated, only artifact is seen deep to the pleural surface.

Ultrasonographic abnormalities

“Comet tail” artifacts
Comet tail artifacts are bright white hyperechoic reflections on the pleural surface. They occur due to the presence of a small area of nonaerated lung in the peripheral parenchyma. The ultrasound beam penetrates through the area due to the lack of aeration and is then reflected back once normally aerated lung is encountered. The resultant artifact forms a characteristic ‘comet-tail’. Comet tail artifacts are nonspecific findings and may represent small areas of consolidation, fluid accumulation within the parenchyma, or scarring from a previous episode of pulmonary disease. Comet tail artifacts which are diffuse and extend beyond the ventral aspect of the lungs are considered clinically significant.

Pleural fluid
If fluid accumulates within the pleural space the visceral pleural surface will be separated from the thoracic wall by the fluid and will thus appear deeper than normal. The appearance and amount of fluid should be characterised. Anechoic fluid is likely to have low cellularity and protein concentration, whilst increasing echogenicity is characteristic of highly cellular fluid. Hyperechoic, swirling pleural fluid is characteristic of haemothorax.

The amount of fluid within the pleural cavity can be estimated by determining the height of the imaged fluid. If fluid can be visualised within the dorsal most portions of the pleural cavity, 15–30 l (or more) of fluid (depending on size of the horse) may be present. Because horses typically have a fenestrated mediastinum, pleural fluid accumulation is typically bilateral, although inflammatory diseases such as pleuropneumonia may result in occlusion of these fenestrations.

Fibrin
Fibrin accumulation within the pleural cavity is a common sequela of inflammatory pleural diseases such as pleuropneumonia. Fibrin appears as hypoechoic to hyperechoic strands or as sheets that line the pleural surfaces. With disease chronicity, fibrin can form adhesions between pleural surfaces and to the diaphragm, which can interfere with the normal gliding movement of the lungs. Fibrin strands can cause loculations within the pleural fluid, resulting in a ‘lace-like’ appearance.

The pericardial diaphragmatic ligament should not be confused with fibrin strands. This is a normal pleural reflection, extending from the pericardium to the diaphragm, becoming ultrasonographically visible when pleural fluid causes it to ‘float’ within the effusion. It is typically thicker than fibrin.

Consolidation
Consolidation of the lung refers to a lack of aeration in the pulmonary parenchyma due to an accumulation of fluid and/or a cellular infiltrate. Ultrasonographically, consolidated areas are characterised by a loss of the characteristic bright white hyperechoic line of the pleural surface and replacement with a hypoechoic area in the parenchyma. If the ventral lung tip is consolidated, it appears as a triangle or wedge-shaped area. Air bronchograms, seen as hyperechoic free gas echoes within the hypoechoic consolidated lung, may be seen if the area of consolidation is extensive.

Atelectasis
Compression of the pulmonary parenchyma typically is associated with pleural effusion. The ventral portion of the lung tip appears as a narrow triangular structure in which both bronchi and pulmonary vessels can be imaged. In comparison to consolidated lung, the atelectatic lung tip appears to float within the pleural fluid.

Pulmonary abscesses and masses
Abscesses appear ultrasonographically similar to consolidation, as a hypoechoic area of lung. However, abscesses lack normal...
parenchymal anatomy and, as such, air bronchograms will not be seen within an abscess. An abscess is usually more anechoic than an area of consolidation. Capsules may be seen in abscesses caused by *R. equi* but are otherwise not commonly identified.

**Cranial mediastinum**

Abnormalities of the cranial mediastinum include fluid accumulation, abscesses and masses. It is the most ventral aspect of the thorax and is thus usually filled with fluid in horses with pleural effusion. The fluid may be uni- or bilateral, depending on the integrity of the mediastinum. Abscesses can develop as a result of pleuropneumonia. Other masses may be identified as homogenous or heterogenous soft tissue accumulations.

**Pneumothorax**

Accumulation of air/gas within the pleural cavity can occur as a result of thoracic trauma, anaerobic pleuropneumonia with gas-producing bacteria or a bronchopleural fistula. Pneumothorax without significant pleural fluid accumulation can be challenging to identify, as the air appears ultrasonographically similar to the pleural surface. In contrast to the pleural surface which moves with respiration, the linear hyperechoic echo of a pneumothorax will be static with respiration.
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Dealing with complications of castration

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Equine castration is such a commonly performed technique in equine practice that is often considered to be completely routine. However, it is a technique that is recognised to be associated with complications and these can represent minor nuisances or life-threatening catastrophes. Knowledge of potential complications can help their early recognition and appropriate treatment leading to the optimum outcome.

The prevalence of castration complications has been broadly reviewed and would appear to be around 10% (de Ban 1970; Johnson 1973; Lindley 1982; Moll et al. 1995; Mason et al. 2005; Embertson 2008). One study comparing open standing castration and closed sutured castration found different complication rates for the different techniques of 22 and 6%, respectively (Mason et al. 2005).

Haemorrhage
Some haemorrhage after castration is often inevitable but will usually cease within 20 min. This haemorrhage usually originates from scrotal vessels and is self-limiting. Continued or profuse haemorrhage usually arises from the testicular artery and is a result of an equipment or technical failure during the procedure. In many cases keeping the horse quiet (with chemical sedation if necessary) will result in cessation of the haemorrhage. In severe cases, attempts should be made to identify and occlude the testicular artery. This may be possible in the standing horse with placement of artery forceps or re-emasculature. On occasion general anaesthesia may be required to allow identification of the bleeding vessel. Standing laparoscopic intra-abdominal ligation of the testicular blood vessels has also been described. If severe haemorrhage cannot be stopped by direct occlusion of the testicular vessels then the scrotum may be packed with swabs and sutured closed (Embertson 2008). Alternatively the use of i.v. formalin solutions has been recommended (Schumacher 2006).

Evisceration
Evisceration is an uncommon but potentially life-threatening complication. It usually occurs within 4 h of castration but may occur up to 7 days later. It has been reported to be more common in Standardbred and draught horses and in animals castrated before 6 months of age. It is suggested that this increased risk may be the result of a previous unknown inguinal hernia. If an ‘at risk’ individual is identified then a closed castration technique should be used. Horses invariably show signs of colic if an evisceration is present. Once identified cases of evisceration require protection of the exposed intestine and immediate surgery to lavage and replace it within the abdomen (de Ban 1970; Hutchins and Rawlinson 1972; Schumacher 2006; Embertson 2008).

Omental prolapse
Prolapse of the omentum needs to be distinguished from evisceration by careful inspection and palpation. Rectal examination may also be required. Omental prolapse is not a life-threatening situation. The prolapsed omentum should be resected or emasculated as dorsal as possible and the animal then kept standing for 48 h (de Ban 1970; Schumacher 2006).

Oedema
Oedema of the scrotum is an inevitable consequence of castration and may extend to the prepuce. It is usually most marked at 4 days. It can be minimised by the institution of an exercise regime after castration and by resection of a large portion of the scrotum. Usually it is self-resolving but the swelling can lead to premature sealing of the scrotal incisions. Treatment requires exercise and opening of the scrotal incisions by scrotal massage or use of a sterile gloved finger (Schumacher 2006; Embertson 2008).

Septic funiculitis
Infection of the spermatic cord remnants is more likely after open castration as this tissue is left in the scrotum but may be found in association with the ligature placed at closed castration. Treatment requires antimicrobial therapy in conjunction with local drainage. Resection of the spermatic stump may be necessary. Schirrous cord describes the presence of chronic enlargement and/or discharge as a result of a Staphylococcal infection of the spermatic cord. It may take months to years to appear. Resection of the affected tissues is usually required. Clostridial infection of the scrotal tissues is rare but may cause a malignant oedema like condition with severe pyrexia, depression and toxaemia. Treatment with penicillin and NSAIDs is required together with scrotal debulking and drainage.

Septic peritonitis
As the vaginal tunic communicates directly with the peritoneal cavity there is always the potential for peritonitis after castration although this complication is rare. Treatment is with antimicrobial and supportive therapy. Rarely abdominal adhesions may develop between intestine and the internal inguinal ring which may be a consequence of a local peritonitis or haemorrhage from the intra-abdominal spermatic cord or vas deferens usually leading to colic signs similar to gut-tie in cattle (Rafferty 1997; Scott et al. 1997; Scott 1997).

Penile damage
Damage to the penis is usually iatrogenic during the castration procedure and is a result of incorrect identification of the structures. Repair is usually dependent on the tissues damaged. Paraphimosis rarely occurs as a consequence of sedation for
standing castration. Physical support and massage may be required together with systemic anti-inflammatory therapy.

**Hydrocoele**
Sterile fluid accumulation in the vaginal tunic may appear months to years after castration. It is usually unsightly but not clinically significant. It can usually be left alone or surgical resection performed (Schumacher 2006).

**Incomplete castration**
This complication usually arises during the castration of a cryptorchid individual where the tail of the epididymus has a long attachment to the testes and mistakenly only this epididymus is removed leaving an inguinal or abdominal testis. The horse will continue to show stallion behaviour and requires further cryptorchid surgery to remove the remaining testicular tissue.

**References**

**NOTES**
Cryptorchidism ('hidden testis') refers to the failure of descent of one or both testis from the fetal position in the sublumbar region close to the kidney to the normal adult position in the scrotum. It is the most common, nonlethal developmental defect in the horse, occurring in approximately 1% of all male births.

Three distinct groups of cryptorchids are described that depend on the position of the affected testis:

1. Complete abdominal cryptorchid - the testis and epididymis are located within the abdomen.
2. Partial abdominal cryptorchid - the testis is located in the abdomen and the epididymis in the inguinal canal.
3. Inguinal cryptorchid - the testis and epididymis are located in the inguinal canal or adjacent to the superficial inguinal ring within the inguinal fascia. These animals are sometimes referred to as 'high flankers'.

A number of large retrospective studies have investigated the incidence of right vs. left cryptorchidism and indicate that failure of descent occurs with nearly equal frequency. However, the location of the retained testis may vary with side. One study found abdominal cryptorchidism to be left sided in 75% of cases, while right-sided abdominal retention was 42%. This difference is most likely due to the fact that the left testis is larger during development; therefore, if the gubernaculum does not sufficiently enlarge the vaginal ring, the larger left testis has less chance of passing successfully through it.

If the animal was bred and reared by the owner, its behavioural and castration history is of value. However, frequently this information is not available and the condition is noticed only when the animal is presented for castration. Diagnosis in such cases is based on methodical clinical examination, scrotal, inguinal and rectal palpation, ultrasonographic examination, hormonal assays and, in some cases, surgical exploration.

Following confirmation of the diagnosis, a variety of surgical techniques have been described to isolate and remove the retained testis, these include inguinal exploration, laparoscopy and laparotomy. However, it should be noted that in almost all cases, even abdominally retained testis can be retrieved via the inguinal canal and a laparotomy is not necessary. Furthermore, the scrotally located testis must never be removed prior to the cryptorchid testis and anectodal reports that removal of the descended gonad facilitate descent of the retained testis are unfounded.

Treatment of cryptorchids is a challenge for any surgeon and it is often said that no 2 cryptorchidectomies are the same. The introduction of standing laparoscopic surgery has certainly revolutionised the treatment of these horses and no doubt will become even more widespread in the future. However, given the requirement for considerable training and expensive equipment, more traditional methods are frequently still employed.

The keys to effective treatment are a good history, thorough clinical examination, an in-depth knowledge of the events surrounding testicular descent, the surgical anatomy of the region and the variations that may be encountered. Recognition of the remnants of a partially removed testis, amputated epididymal tail or congenital abnormality may be essential to success.

In 1875 Degive, a well known cryptorchid surgeon, suggested that “When one has done one’s hundredth cryptorchidectomy, one hasn’t done one’s hundred and first” This is as true today as ever it was.

Further reading
Angular limb deformities are defined as medial or lateral deviations of the limb in a frontal plane. Careful clinical assessment is required to define the deformity. This should include examination whilst standing square and with the limbs positioned straight beneath the body and when walking. Visual assessment should be made from directly in front of the joint being assessed to avoid misinterpretation as a result of concurrent rotational deformity. Radiographic examination is also critical in assessment and, in addition, enables quantitative evaluation of the pivot point and pivot point angle. When assessing a foal with an angular limb deformity, the clinician must consider in combination the age of the foal, remaining growth potential at the site of angular deformity, cause and severity of deformity. Only after considering these factors can a suitable treatment plan be formulated.

Congenital deformities

Periarticular laxity
This is a common cause of angular limb deformity in neonates, requiring no intervention other than limiting exercise. Dramatic improvement is usually seen within the first few weeks of life.

Cuboidal bone hypoplasia
This condition most frequently results in angular limb deformities at the carpus and is seen most commonly in premature and dysmature foals. The angular deformity develops after the foal begins to weight bear, due to plastic deformation of the cartilaginous precursors of the cuboidal bones. Confinement is indicated to minimise stresses of load bearing. When severe, the limbs should be maintained in normal alignment by sleeve cast immobilisation. Casts should be maintained for 10–14 days before removal and re-evaluation both clinically and radiographically.

Acquired deformities

Angular limb deformities also will (commonly) result from disproportionate growth at the level of the physis. These occur as a result of developmental factors after birth. If relatively more growth occurs at the medial aspect of the physis, valgus deformities occur. Conversely, if more growth occurs at the lateral aspect of the physis, varus deformities occur. The most common deformities seen in the UK are carpal valgus deformities, and fetlock varus deformities.

Conservative management
In most cases, minimal intervention is all that is required to correct angular limb deformities. This includes exercise restriction and careful attention to the foot. In the first instance, the foot should be carefully balanced. Extensions alter the weightbearing surface of the foot and, in turn, axial load of the limb, in the direction of the extension. By applying the extension to the lateral aspect of the hoof with varus deformities and the medial aspect with valgus deformities, a more physiological axial loading of the limb (and physis) is achieved (Greet and Curtis 2003). This in turn encourages correction of the angular deformity. In the author’s hands, the most simple and effective type of extension is a moulded polymer urethane (Equithane®) bonded directly to the hoof.

Surgical management
Surgical intervention is based on the fact that the vast majority of bone growth occurs at the level of the physis. Any intervention performed has the aim of altering the growth process at the physis. Although a number of different surgical methods are used, they rely on the principles of either growth acceleration or growth retardation, across one side of the physis. Indications for surgical intervention include deformities that are nonresponsive to conservative treatment, deformities which are progressive with age, or severe in young animals. Surgical intervention is relatively infrequently required but when necessary this must be performed in a timely fashion. As a guide, surgical intervention should ideally be performed for fetlock deformities before 2 months of age and carpal and tarsal deformities before 6 months of age.

Growth acceleration
Periosteal strip (hemi-circumferential periosteal transection and elevation)
This technique strips off the outer (periosteal) covering of bone adjacent to the growth plate, accelerating growth on the operated side. Over-correction does not occur with this technique, although its efficacy has been questioned (Sloane et al. 2000), and certainly it does not produce results as dramatic as the retardation techniques.

Growth retardation (transphyseal bridging)
Different techniques are available for bridging of the physis. Each technique has different advantages and disadvantages. All require a second surgery to remove the bridge once the deformity has been corrected. When selecting the method to be used, efficacy, complications and cosmetic results all have to be considered.

- Transphyseal screw: (Witte et al. 2004; Kay et al. 2005; Roberts et al. 2009). Probably the most common technique currently employed, the screw is inserted in a neutral fashion, across the physis from proximal to distal, limiting growth on the bridged side. The cosmetic result is usually excellent as the incision is very short. Surgical time is also reduced compared to other techniques, and improvements in angulation have been reported to be both greater and occur at a faster rate. In occasional cases over-correction has been seen after screw removal.

- Screws and wires: (Fretz and Donecker 1983). A combination of 2 screws and wires in a figure 8 configuration is also common, particularly at the distal radial physis. This is a slightly more complicated surgery and cosmesis is not as good. However, the technique avoids bridging through the physis, so over-correction after implant removal should not occur.

- Staples: (Heinze 1963). Physseal stapling has become much less commonly employed in recent years. Compared to the above techniques staples offer a lesser degree of correction, achieved at a slower rate) and a larger incision is required, compromising cosmetic outcome.
Saturday 11th September 2010

Further reading

NOTES

Historically, post operative ileus (POI) was defined as any post operative complication that resulted in reduced intestinal transport. More recently, the term has been taken to describe a syndrome of (transient) gastrointestinal motility disturbance that is seen shortly after abdominal surgery. In particular, it is related to procedures involving intestinal manipulation. Mechanical obstructions are usually specifically excluded and POI is considered a functional obstruction in which, in most cases, pharmacological treatment is beneficial. The motility disturbance may affect any segment of the gastrointestinal tract, although in horses the stomach and small intestine appear more susceptible. In equine clinical practice, the presence of an increased volume of gastric reflux on stomach intubation after colic surgery is commonly regarded as pathognomonic for POI (although the precise criteria to determine an increased amount of reflux are open to debate). Other clinical signs usually include colic, reduced intestinal borborygmi, tachycardia and dehydration (Merritt and Blikslager 2008). More recently, this view of the pathogenesis of POI has been questioned and the possible role of mechanical obstruction to the intestinal tract has been proposed (Freeman 2008). The incidence of POI has been reported to be 10–47% of abdominal surgeries and there is a reported mortality of 13–86% of cases of POI (Blikslager et al. 1994; Freeman et al. 2000; French et al. 2002; Morton and Blikslager 2002; Mair and Smith 2005). POI has been associated with 38–40% of post operative deaths in horses treated for colic (Blikslager et al. 1994; Roussel et al. 2001).

Currently, the aetiology of POI is not fully understood and, with the clinical diagnosis often open to debate, future progress in research is likely to be slow. There are, however, a number of studies of the possible pathogenesis and risk factors for POI, knowledge of which may help in its prevention.

Inflammation of the intestinal tract may result from the primary pathological lesion or from manipulation during its surgical correction. Such inflammation of the intestinal muscle layers and myenteric plexi may disrupt motility leading to POI (Little et al. 2005). Minimising this inflammation is a prime goal in the prevention of POI. Early recognition of a surgical lesion and prompt surgical correction is therefore vital to limit inflammation resulting from the primary pathology. Careful handling of the intestine and good surgical techniques are also required to minimise any secondary inflammation caused during the correction procedures. Decompression of the gastrointestinal tract by the end of surgery is also important (Cohen et al. 2004).

Careful assessment of intestinal viability is essential to avoid leaving compromised intestine in the abdomen as this ischaemic bowel has been proposed as a cause of POI together with the inevitable secondary endotoxaemia (Hardy and Rakestraw 2006). Peritonitis as a result of abdominal contamination during surgery will also contribute to the development of POI.

Specific risk factors identified for POI in the horse include the Arabian breed, age greater than 10 years, dehydration (raised PCV and protein concentration), elevated glucose concentration, prolonged anaesthesia and/or surgery, performance of a resection and anastomosis, a small intestinal lesion and small intestinal ischaemia (Blikslager et al. 1994; Roussel et al. 2001; Cohen et al. 2004; Holcombe et al. 2009). Some of these factors are unalterable but many can be minimised or avoided by prompt surgical attention and good surgical technique.

Dehydration may be addressed prior to surgery but this should not be at the expense of delaying surgical intervention. Intravenous fluid therapy can be commenced during surgery but over-hydration should be avoided. Post operatively i.v. fluids are usually continued to provide maintenance fluid requirements and slowly correct any underlying deficits. Over-hydration should again be avoided.

Electrolyte disturbances, usually as a result of fluid sequestration in the intestinal lumen and exacerbated by excessive nasogastric reflux, may be present prior to surgical treatment. Decreases in potassium and chloride are most commonly seen and hypocalcaemia may also be present. Electrolyte status should be assessed after surgery and any deficits corrected by fluid supplementation.

Prophylactic treatment with lidocaine has been associated with a reduced incidence of POI and may be a useful measure in high risk cases (Trots et al. 2009). Whilst the presence of increased reflux on nasogastric intubation is the key finding to identify POI, the practice of frequent or indwelling intubation has been recently questioned. In man a decreased frequency or absence of nasogastric intubation, together with an early return to enteral feeding, has been shown to be safe and beneficial in reducing POI (Cheatham et al. 1995). Many equine surgeons are now adopting this approach.

References


NOTES
Incisional complications following colic surgery remain a significant cause of morbidity despite the universally reported improvement in success rates over the past 2 decades or so. Complications extend from peri-incisional oedema/cellulitis through incisional discharge and suppuration, ultimately to dehiscence and even eventration. Most incisional complications will lead to patient discomfort and increased costs (due to hospitalisation and/or treatment). At worst, they might be fatal. There are a number of potential risk factors for incisional complications although firm clinical evidence is lacking, most studies being inevitably compromised by the limitations of retrospective audit and/or confounding influences in what is likely to be a multi-factorial problem.

Possible factors include:
- Contamination (at the time of or after surgery)
- Length of incision
- Duration of surgery
- Closure technique (choice of suture material and pattern)
- Patient characteristics (weight, metabolic status, nutritional status)
- Trauma and tension to wound edges (swelling, over-exertion)
- Antimicrobial regimes (routine prophylactic spectrum, parenteral and/or topical application)
- Surgical technique
- Repeat laparotomies

Each of the possible factors will be discussed in the context of the author’s experience and that of colleagues at The Liphook Equine Hospital. Preliminary results of an ongoing prospective clinical study will be presented in the context of a review of literature already published on the subject.
Saturday 11th September 2010

Management of post operative ileus
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There is no doubt that avoidance of post operative ileus (POI) is the optimum strategy when managing horses which require acute abdominal surgery. Post operative ileus results in a significantly increased cost of post operative care (Merritt and Blikslager 2008) and a reported mortality rate of 13–86% (Blikslager et al. 1994; Freeman et al. 2000; French et al. 2002; Morton and Blikslager 2002; Mair and Smith 2005). However, even with the best intentions, clinicians will inevitably be faced with horses with POI following colic surgery.

Nasogastric intubation has been the mainstay in the diagnosis and management of POI. In cases with marked gastric distension it will be life-saving in avoiding the potential for fatal gastric rupture. Regular gastric decompression may help the re-establishment of gastrointestinal function as well as reducing abdominal discomfort. It has also been used as a means of monitoring the presence and severity of POI and response to treatment. However, recently there has been concern that in-dwelling or very frequent nasogastric intubation may be counterproductive. In man, reducing or withdrawing routine nasogastric intubation together with early enteral feeding has been shown to be beneficial in reducing POI (Cheatham et al. 1995). It is now suggested that nasogastric intubation should only be performed in cases with known gastric distension at the end of surgery or showing signs of colic with an elevating heart rate in the post operative period.

Abdominal ultrasonography allows the noninvasive identification of gastric, duodenal and/or jejunal distension. Subjective assessment of motility can also be made and response to therapy can be monitored. It can be used as an adjunct to reduce the necessity for nasogastric intubation.

When faced with a horse with excessive reflux of stomach content, abdominal pain and raised heart rate following colic surgery, it is imperative to distinguish between a functional obstruction and a mechanical obstruction (Freeman 2008). Functional obstructions (true POI) result from physiological disturbances to the gastrointestinal tract and will usually respond to medical treatment. Mechanical obstructions result from physical blockage to the intestinal tract and, whilst they may respond to time and adaptation, will often benefit from early surgical intervention. In many cases, these mechanical obstructions are a consequence of surgical complication or error and may therefore be related to the complexity of the initial lesion.

Medical management of POI involves correction of any fluid, acid-base or electrolyte disturbances. Intravenous fluids (crystalloids or colloids) with electrolyte supplementation are used as determined by clinical and clinicopathological parameters. Antibacterial therapy is indicated if there is a risk of peritonitis from ischaemic intestine or luminal contamination. Analgesic and anti-inflammatory therapy are required to provide pain relief and reduce intestinal inflammation. NSAIDs at standard or reduced doses are often used as they have the least effect on gastrointestinal motility. More profound analgesia may be provided by butorphanol or α₂ agonists (xylazine) but both these drugs adversely affect gastrointestinal motility. If persistent pain is present, which is not relieved following gastric decompression, then a mechanical obstruction must be suspected.

Intestinal prokinetics are currently the most commonly used treatment for POI. A range of drugs have been proposed to stimulate or improve gastrointestinal motility. Bethanechol, neostigmine, acepromazine, yohimbine, metaclopramide and cisapride have all been proposed and used in the treatment of POI (Hardy and Rakestraw 2006; Cook 2009). However, lack of efficacy and the presence of side effects have limited their widespread use in clinical practice.

The most commonly used prokinetic is lidocaine, for which there is evidence of efficacy available (Cook and Blikslager 2008; Cook 2009). The prokinetic mode of action is not clear. Lidocaine also has analgesic and anti-inflammatory actions, which may be beneficial. Lidocaine is administered as an initial bolus of 1.3 mg/kg bw (followed by a continuous infusion of 0.05 mg/Kg bw/min). The therapeutic range for lidocaine is narrow, and care must be taken to avoid accidental overdosing. Initial treatment with lidocaine can be commenced during surgery, but the infusion must be stopped at least 30 min before the end of anaesthesia.

The most common alternative prokinetic to lidocaine is erythromycin. This acts by stimulating motilin receptors and increasing myoelectric complexes. Down regulation of the receptors may occur with the use of frequent high doses of erythromycin resulting in reduced effects. Various dosage regimes have been proposed but recently many clinicians are using erythromycin at a very low dose (20–50 ml of a solution of 1 g erythromycin dissolved in 1 litre saline administered i.v. every 1–4 h). The precise sites of action of erythromycin in the colic horse are unclear but it has gained popularity in the treatment of caecal dysfunction.

Nursing care of the POI horse is also vital. Early feeding and handwalking exercise following surgery are used in clinical practice and may also stimulate gastrointestinal motility (Cook 2009).

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Laminitis
Chaired by Marianne Sloet
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Are there any correlations between external hoof capsule measurements and distal phalanx measurements?


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Aims: Foot pain is a major cause of forelimb lameness. There is limited information about orientation of the distal phalanx (P3) within the hoof capsule and its relationship with foot conformation. The objectives of this study were to determine relationships between external angles and linear ratios of the hoof capsule and the angles of P3. Methods: Photographs and lateralomedial radiographs of 300 feet from 300 horses examined at the Animal Health Trust with foot pain were analysed. Hoof wall, heel and coronary band angles, hoof wall length and height, weight bearing length, coronary band length and dorsal and palmar height of the coronary band were measured on photographs. The following angles to the horizontal were measured on radiographs: dorsal hoof wall (Angle W); dorsal aspect of P3 (Angle P); concave, parietal solar surface of P3 (Angle C); solar border of P3 (Angle S). The reflex angle of P3 (Angle RA), length of the solar aspect of P3, height of P3 extensor process, weight bearing length of the foot and dorsal coronary band height were also measured. Descriptive statistics were undertaken and Spearman’s Rank Correlations were used to test for associations between measurements. Results: External hoof capsule angles were weakly or moderately, positively correlated to P3 angles and weakly, negatively correlated to certain linear ratios. There was considerable variation between feet in angles C and S. Conclusions and practical significance: Angles and linear ratios of P3 could not be accurately predicted by external measurements of the hoof capsule. More work is required using sound horses to determine whether stronger correlations are seen and if there are breed differences in P3 shape. Clinicians should be careful assuming that foot conformation is an indicator of P3 position in horses with foot pain. Acknowledgements: The Bransby Home of Rest for Horses for funding.

The role of weather conditions in the occurrence of white line abscessation in donkeys in the UK

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Aims: Hoof disorders are very common in donkeys in the UK and include white line disease, laminitis, seedy toe and onchomycosis. This study seeks to evaluate the role of environmental moisture levels in the development of white line abscessation (WLA). Prolonged exposure to water, urine and faeces has previously been shown to cause damage to the hoof wall in horses. We hypothesise that increased environmental moisture will be associated with an increase in the occurrence of WLA in donkeys in the UK. Methods: This study correlates the occurrence of WLA in a population of donkeys at the Donkey Sanctuary, Devon, with local levels of rainfall and sunshine. The hoof wall moisture content in healthy and diseased animals in the UK was assessed for forelimbs and hindlimbs and for healthy individuals in the and environment of Luxor, Egypt. Results: A positive correlation between rainfall and incidence of WLA was found and a negative correlation between incidence of WLA and levels of sunlight. In forelimbs the hoof wall moisture was significantly higher in diseased (mean ± s.d. 35.7 ± 1.71%) compared to healthy hoof samples (mean ± s.d. 29.9 ± 3.47%). In hindlimbs there was no significant difference between the hoof wall moisture content of healthy (mean ± s.d. 39.4 ± 1.60%) and diseased (mean ± s.d. 34.0 ± 7.35%) samples. The moisture content in the hindlimbs was significantly higher than that in the forelimbs. Samples from Egypt had a significantly lower level of hoof wall moisture (mean ± s.d. 25.0 ± 5.38%) than UK samples. Conclusions: This study concludes that increased environmental moisture plays a role in the development of white line problems in the donkey amongst other predisposing factors. Practical significance: The control of environmental moisture levels may provide a way to reduce the occurrence of white line problems in the donkeys in the UK.

Plasma fructosamine elevations in horses with laminitis

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Aims: 1) To compare levels of plasma fructosamine (a marker of abnormal glucose homeostasis used in humans and small animals) in horses that present with laminitis with normal controls. 2) To investigate associations between elevated fructosamine at presentation in laminitic horses with: a) Single sample markers of insulin resistance, b) Outcome. Methods: Plasma fructosamine, fasted insulin and glucose were assayed on blood samples taken, (between 07.00 and 09.00 h) 24–72 h after diagnosis of laminitis from 30 horses that presented as first opinion cases to Bell Equine Veterinary Clinic between April and September 2009. Details of: signalment, clinical examinations, further diagnostics, treatment, management and outcome at 6 weeks were recorded. Plasma fructosamine was also assayed in a separate group of 19 nonlaminitic control horses. Results: Laminitic horses had significantly higher mean plasma fructosamine levels than normal horses (P<0.001 Welch’s t test). Laminitic mean = 288 µmol/l (s.d. = 43 µmol/l) Normal mean = 253 µmol/l (s.d. = 19 µmol/l). Thirteen of 30 laminitic horses had fasting hyperinsulinaemia (>20 µIU/ml) 2/30 had fasting hyperglycaemia (>6.9 mmol/l). In laminitic horses, nonparametric univariable analysis revealed statistically
significant correlations between plasma fructosamine and fasting insulin, fasting glucose and RISQI (a proxy for insulin sensitivity). Trends for association between elevated plasma fructosamine and negative outcome at 6 weeks did not reach statistical significance. **Conclusions and practical significance:** Hyperglycaemia is infrequently detected in horses. Plasma fructosamine may be a useful marker of transient hyperglycaemia associated with insulin resistance in horses with Equine Metabolic Syndrome or Equine Cushings Disease. Longer term follow-up of these cases and/or a larger study are required to assess the value of fructosamine as a prognostic indicator. These data support hypotheses implicating hyperinsulinaemia and aberrant glucose homeostasis in the pathogenesis of laminitis. **Acknowledgements:** This study was generously funded by a grant from the RCVS Trust.

**09.15–09.30**  
**Insulin and ACTH values in donkeys with and without laminitis in the UK**  
**du Toit, N., Trawford, A.F. and †Keen, J.A.**  
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**Aims:** To determine the values of insulin and ACTH in donkeys and evaluate the possible association of insulin resistance and pituitary pars intermedia dysfunction with the prevalence of laminitis. **Methods:** Blood samples were collected from 394 donkeys as part of routine clinical evaluation of new relinquishments to The Donkey Sanctuary, UK and insulin and ACTH were measured. Records were kept of the age, sex, body condition score (5 grade scales), history of previous laminitis and development of clinical laminitis within one month post sampling. Multivariate analyses were performed to determine statistically significant associations. **Results:** ACTH was only determined in 126 donkeys. The median age of donkeys was 12 years (range 1–49) and median BCS was 3.5. Of the 394 donkeys, 19% had a history of previous laminitis and 11% developed laminitis within one month post sampling. The normal mean values (± s.e.) of insulin (µIU/ml) and ACTH (µg/ml) in nonobese donkeys (BCS ≤ 3.5) without a history of laminitis were 4.95 (0.51) and 40.23 (3.42) respectively. Mean (± s.e.) insulin levels were significantly greater in donkeys with a history of laminitis (23.84 ± 4.17) vs. those without (8.51 ± 0.97), (P<0.001); and greater in obese donkeys (20.86 ± 2.60) vs. nonobese donkeys (7.28 ± 1.13) (P<0.001). There was no significant difference in mean ACTH levels (µg/ml) amongst those donkeys with or without a history of laminitis (51.73 ± 7.21 vs 39.61 ± 3.00), or with or without laminitis within a month post sampling (46.58 ± 9.92 vs. 41.08 ± 2.91) (P=0.11). **Conclusions:** Higher insulin values were significantly associated with a history of laminitis and clinical signs of obesity, indicating that insulin resistance may be an important risk factor associated with laminitis in donkeys. **Practical significance:** This study has determined normal values for insulin in the donkey. Evaluation of insulin values in donkeys may be a useful screening tool to identify donkeys at risk of developing laminitis.

**09.30–09.45**  
**Preliminary results of an epidemiological study on equine laminitis**  
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**Aims:** To determine risk factors for laminitis in Great Britain using a prospective cohort of horses/ponies under the care of a random sample of compliant practices, representative of the general equine veterinary population. **Methods:** A nested case-control study within the cohort study was used to quantify significant risk factors with data on exposure variables collected via owner-completed questionnaires. Sample size calculations indicate that 150 cases and 600 controls will be required to detect a minimum effect size of 2.0 based on assumptions of 5% significance, 80% power and a minimum exposure rate of 10% among controls and 4 controls per case. Preliminary analyses were conducted using Chi-squared/Fisher’s exact and univariable logistic regression analyses to examine associations between selected risk factors and laminitis. **Results:** As of January 2010, 208 cases of laminitis were reported with 141 corresponding case questionnaires sent to owners willing to participate (67.8%). Eighty-one completed case questionnaires and 293 completed control questionnaires were received. Variables associated with an increased risk of laminitis were: previous episodes of laminitis (OR = 3.6, P = 0.042), not wearing shoes (OR = 1.7, P = 0.04), Cushing’s disease (OR = 3.2, P = 0.01), Equine Metabolic Syndrome (OR = 3.6, P = 0.04) and retired horses compared to pleasure horses (OR = 2.3, P = 0.01). Variables associated with a decreased risk of laminitis were: geldings compared to mares (OR = 0.5, P = 0.01), height greater or equal to 15 hh (OR = 0.3, P<0.001), transportation (OR = 0.2, P<0.001), fed hard food (OR = 0.2, P<0.001), competition horses compared to pleasure horses (OR = 0.6, P = 0.005). Variables with no statistically significant associations were: breed type (cross-breeds vs. pure-breeds), new health conditions and current medications. **Conclusions and practical significance:** These preliminary analyses have identified some modifiable factors significantly associated with laminitis. Further multivariable analysis on complete data should identify risk factors of practical significance, specific to Great Britain, and inform management strategies to prevent/minimise laminitis. **Acknowledgement:** This project is funded by World Horse Welfare.
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09.45–10.00

Disease prevalence in a cross-sectional study of geriatric horses

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Aims: To investigate disease prevalence in geriatric horses and ponies aged ≥15 years in North West England and North Wales.

Methods: From responses to a questionnaire survey of owners of geriatric horses (n = 918/1144), 200 horses were selected to receive a noninvasive veterinary clinical examination, using systematic random sampling. Results: Clinical examinations were performed within 8 weeks following return of the questionnaire. The median age of horses was 20 years, (range 15–40, IQ range 17–25 years). Twenty-six percent of horses were overweight (body condition score >3/5) and 4.5% underweight (BCS<2/5). Seventy-one percent had a dermatological abnormality and 18% displayed hirsutism or abnormal moulting. When assessed at walk, 18.7% were lame on at least one limb, while 49.2% were lame in trot. The majority of animals (83.5%) had a reduction in range of motion in at least one joint. Eighty percent of horses had hoof abnormalities. The prevalence of cardiac murmurs was 20.5%. Seven percent of horses had a spontaneous cough during the examination, although 17.5% had some form of nasal discharge, and 19.5% had abnormalities on thoracic auscultation at rest. Following rebreathing, 15% developed adventitious noises and 8.5% coughed. Ophthalmic lesions frequently indentified were vitreous degeneration (64.6%), cataracts (58.5%), and senile retinopathy (33.7%). Dental abnormalities were identified in 95.4% of cases, with cheek teeth diastema in 43.3%, excessive wear/cupped out teeth 38.6% and focal overgrowths in 35.2%. Conclusions: Prevalence of several health problems was high, with under reporting or under recognition of disease by owners of geriatric horses. Practical significance: This is the first major study investigating disease prevalence in geriatric horses in the United Kingdom; further description of disease prevalence and identification of risk factors will aid improvements in veterinary care, owner education and welfare. Acknowledgement: C. Scantlebury’s scholarship is generously funded by The Horse Trust.

References


10.00–10.15

Recurrent colic in general practice; frequency and risk


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Aims: The incidence of recurrent colic in the UK general practice population is unreported. Published studies noted 11–16% of horses had more than one colic episode (Kanene et al. 1997; Tinker et al. 1997; Hillyer et al. 2001; Traub-Dargatz et al. 2001) and previous medical colic is a risk factor for many types of surgical colic. This longitudinal study aimed to estimate incidence and risk factors for recurrent colic among horses attended by first-opinion vets in the northwest. Methods: Horses with medical colic and no history of colic surgery were recruited prospectively by participating practices. Owners completed baseline and follow up telephone questionnaires over one year. Variables included; signalment, colic details, dental and parasite prophylaxis, diet, turnout, exercise and behaviour. Further colic episodes were defined as recurrence if the horse had been free from colic, passing normal droppings and eating normally for 48 h. Results: Among 127 horses there were 59 episodes of recurrent colic in 43 horses (33.9%). Four (3.1%) of these resulted in surgery, 4 (3.1%) were subjected to euthanasia and 10 (7.9%) had 2 or more recurrences. The incidence was 0.5 episodes per horse-year-at-risk including all vet-visited and owner reported episodes. Univariable analysis of non-time-varying covariates identified horses that windsuck/crib-bite (OR 4.6 CI 1.3, 16.2 P = 0.02), weave (OR 3.9 CI 1.1, 14.1 P = 0.04), chew wooden objects (OR 2.2 CI 1.0, 5.0 P = 0.05) or have known dental pathology (OR 7.6 CI 1.9, 29.4 P = 0.001) have increased risk of recurrence. Conclusions: Recurrent colic is common in general practice. The behavioural risk factors may indicate an aetiological link or may be proxies for particular individuals that are at increased risk. Dental abnormalities may lead to recurrent colic possibly due to inadequate mastication. Practical significance: The reported incidence may be used as a gauge for comparison in similar populations and as a baseline for monitoring the efficacy of preventative strategies. Acknowledgement: C. Scantlebury’s scholarship is generously funded by the Horse Trust.

References


11.10–11.25
Identification of risk factors for traumatic injuries in the general horse population of the UK


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Aims: To determine the prevalence and type of traumatic injuries in the general horse population of North West England and to identify possible risk factors associated with such injuries.

Methods: A questionnaire was mailed to 952 horse owners. Univariable and multivariable logistic regression analysis was performed with the binary outcome variable defined as whether or not the horse had sustained an injury within the previous 12 months. Results: A useable response rate of 68% was achieved. Forty percent of horses had sustained a traumatic injury within the past year. Seventy percent occurred in the field and 14% percent during ridden exercise. The distal limb was most commonly affected (45%) followed by the proximal limb (17%). Nineteen percent of injuries were of unknown cause, 17% due to kicks, 7% bites, 13% from a slip or fall and 9% were fencing-related. Fifty-four percent of injuries were classified as mild. Veterinary attention was sought in 48% cases and analgesia and antibiotics were administered in 67 and 43% cases, respectively. Univariable analysis identified being stabled on a livery yard (P = 0.04) and providing fewer feeding areas in the field (P = 0.01) as risk factors for injury. Multivariable analysis identified the following factors as being associated with an increased risk of injury: Thoroughbred breed (P = 0.02), shorter length of ownership (P = 0.002), being turned out with increased numbers

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Aims: The aim of this study was to evaluate the efficacy of 2 different knowledge-transfer interventions in changing the knowledge of cart horse owners in Ethiopia using a cluster-randomised controlled trial. Methods: We designed and developed 2 knowledge-transfer interventions, a diagrammatic handout and a group presentation with an animal health worker; for educating cart horse owners in Ethiopia about Epizootic Lymphangitis (EZL), a debilitating disease caused of horses by a contagious dimorphic fungus (Histoplasma capsulatum var. farcinosum). Learning objectives included knowledge of the cause of EZL, and prevention and treatment of the disease. A cluster-randomised controlled trial design was used to compare each intervention with the other, and with a control group that received no knowledge-transfer. We aimed to detect a change in knowledge between pre- and post dissemination of 40% and sample size estimates indicated that 4 towns each with 22 owners, per type of intervention tested would give sufficient power. Towns were selected from the Oromia region of Ethiopia, and cart horse owners randomly selected. Knowledge-transfer interventions were randomly assigned to each town. Questionnaires about the owners’ knowledge of EZL were devised to evaluate the effectiveness of the knowledge-transfer interventions, and were administered both pre- and post dissemination (14 days) to assess changes in knowledge levels. Results: Data is available from cart-horse owners in 12 towns. Preliminary analyses suggest that both interventions can achieve significant improvements in knowledge. Further analysis will include multilevel models to allowing for clustering of individuals within towns. Conclusions and practical significance: To our knowledge this is the first cluster-randomised controlled trial aimed at quantifying the effectiveness of different knowledge-transfer interventions for horse owners in either a developed or a developing country. Utilisation of the most effective knowledge-transfer intervention can lead to improved health and welfare of horses. Acknowledgements: RVCS Trust and Wellcome Trust.

10.30–10.45
A matched case control study into a recent outbreak of neurological disease of the central river region of The Gambia. Performed March–June 2009

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Aims: To determine the aetiology of an outbreak of neurological disease with a high mortality rate in the equid population of the African central river region of The Gambia. Methods: A matched case control study (by species and village) was performed. Data collected for each animal included history, clinical examination, packed cell volume, total solids, white and red blood cell count, serology for Trypanosoma equiperdum, west Nile virus, equine encephalosis virus, equine herpes virus and polymerase chain reaction (PCR) for T. congolense, T. vivax and T. brucei. The data were analysed using univariable and multivariable logistic regression. Results: A total of 20 cases and 34 controls were sampled. The typical case presentation was characterised for horses and donkeys and was as follows: Progressive weight loss and ataxia followed by cranial nerve dysfunction inhibiting prehension, depression, hyperaesthesia, hypermetria, circling, end-stage severe ataxia, recumbency and death or euthanasia. Mortality was 83% for donkeys and 75% for horses. Of the potential aetiological agents analysed, antibodies to T. equiperdum (P = 0.04), a strongly positive T. brucei PCR result (P = 0.1) and recent treatment with melarsamine hydrochloride (P = 0.05) remained significant in a multivariable model. Objective clinical parameters significantly associated with cases included low condition score, long capillary refill time and high heart rate (P = 0.008, 0.03 and 0.06, respectively). Conclusions and practical significance: The clinical presentation and clinicopathological data in these cases is consistent with that previously described in cerebral trypanosomiasis. This disease is a serious threat to this equid population. The most likely species are T. brucei, T. equiperdum or T. evansi. The latter 2 are strains of T. brucei and at present cannot be distinguished by serology or PCR. Further work is needed to identify the specific strain involved and design appropriate treatment regimens. Acknowledgements: RVCS Trust (2009 small grant), The Gambia Horse and Donkey Trust.
of horses (P = 0.002), being used for competitive purposes (P = 0.001) and being stabled at all times during the spring (P = 0.001). Conclusions: Traumatic injuries occur frequently in the general horse population with the majority occurring during turnout. Risk factors for sustaining injuries have been identified in association with horse signalment and management practices. Practical significance: This is the first study looking at traumatic injuries in the general horse population; changes in management may be advised to reduce the likelihood of injury.

11.25–11.40
Prioritising the direction of future epidemiological research - a practical use of multi-level modelling
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Aim: Identify which areas of the racing industry are most likely to be associated with, as yet unidentified, risk factors for tendon strain injury during racing in the UK. Methods: In 2000, the British Jockey Club (now the BHA) established the Equine Welfare database that includes more than 200 fields providing race, horse, course, trainer, jockey, and sire details for all races in the UK. The database currently includes details of more than 850,000 individual race starts and has previously been used in the analyses of risk factors for tendon injury during racing. These data were used to develop complex multilevel models of tendon injury in hurdle racing. Three-level hierarchical models were produced to account for the fact that individual starts made by the same horse in different races; starts made by different horses in the same race; etc. are not independent. Results: The greatest proportion of unexplained variability (in terms of the likelihood that an individual start would result in tendon injury) resided at the level of the race. As much as 30% of unexplained variation may be related to race-level factors. Even when accounting for known risk factors, such as going, there still remained a significant degree of unexplained variation (~15%) at the level of the race. This would suggest that there are as yet unmeasured race-level factors that will explain some of the variation in the risk of tendon injury. In contrast very little variation remained at the level of the racecourse. Conclusions: Racecourse-level variables such as track circumference or topography may be less important whereas race-level variables such as movement of running rails or fences and ground maintenance strategies are likely to be of greater significance. Race-level risk factors such as these would be suitable targets for interventions that could have a significant impact of injury risk.

11.40–11.55
Descriptive epidemiology of joint injuries in Thoroughbred racehorses in training
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Aims: (i) To develop a classification system for carpal and metacarpal/metatarsal phalangeal (MCP/MTP) injuries and (ii) to estimate the incidence of exercise-induced carpal and MCP/MTP injuries in young Thoroughbreds in flat race training. Methods: In a prospective cohort study, young Thoroughbreds were monitored from commencement of training in the autumn of 2006 or 2007 until the end of the 2008 flat racing season. Daily exercise records and information on veterinary-diagnosed carpal and MCP/MTP injuries requiring treatment and/or interfering with the planned training programme were collected. Injury rates by age, gender and trainer were compared using Poisson regression. Results: Data were collected on 647 horses from 13 trainers throughout England. In total, 184 cases of carpal (n = 82) or MCP/MTP (n = 102) injury were reported in 165 horses (25.5% of the study population). Cases were classified in one of 4 categories: (1) localised to a carpal or MCP/MTP joint based on clinical examination and/or use of diagnostic analgesia, but no diagnostic imaging performed (n = 21); (2) localised to a carpal or MCP/MTP joint with radiographs taken but no abnormalities detected (n = 21); (3) evidence of an abnormality of subchondral bone and/or articular margin(s) identified using diagnostic imaging (n = 72), and (4) evidence of discontinuity of the articular surface identified by diagnostic imaging (n = 70). Overall joint injury rate was 2.31 per 100 horse months (95% CI 1.99, 2.68). There was no significant difference in joint injury rates between 2- and 3-year-olds or between genders, although males sustained category 3 injuries at almost double the rate of females (P = 0.02). Joint injury rates differed significantly between trainers (P<0.001) and there were trainer differences in anatomical site and severity of injury. Conclusions and practical significance: Carpal and MCP/MTP injuries are a common cause of morbidity in young racehorses. Identification of modifiable risk factors for these injuries may help to reduce their incidence.

11.55–12.10
Arthroscopic approaches to the palmar-plantar pouch of the distal interphalangeal joint of the horse - a comparative study
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Aims: The conventional arthroscopic approach to the palmar/plantar distal interphalangeal joint (DIPJ) may result in inadvertent penetration of the digital flexor tendon sheath (DFTS). This iatrogenic communication would be undesirable subsequent to arthroscopic lavage of a septic DIPJ. A lateral/medial approach

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to the palmar/plantar aspect of the DIPJ will result in a significantly lower rate of inadvertent penetration of the DFTS, whilst still providing adequate intra-articular evaluation. **Methods:** The conventional palmar/plantar and a novel lateral/medial arthroscopic approach to the DIPJ was performed by 2 board certified surgeons (B.M.B, J.P.C.) on fore- and hindlimb cadaver limbs (20 limbs/aproach). Subsequently, India ink was injected into the dorsal pouch of the DIPJ, and the DFTS was examined for the presence/absence of ink. In addition, observations on the number of attempts made to access the joint, evidence of iatrogenic intra-articular trauma and the proportion of the palmar/plantar pouch that was visible were recorded. **Results:** With the conventional approach, DFTS penetration was noted in 14/20 (70%) of the limbs, compared to none with the lateral/medial approach (P = 0.0001). No significant differences were found between the approaches for the number of attempts made to access the joint, the incidence of iatrogenic intra-articular trauma, or the occurrence of restricted visibility of the palmar/plantar pouch. **Conclusions:** The novel lateral/medial approach to the DIPJ avoids inadvertent penetration of the DFTS. **Practical significance:** The novel lateral/medial approach to the palmar/plantar DIPJ is advantageous when iatrogenic communication of the DIPJ and DFTS is to be avoided. **Acknowledgements:** The clinicians of Donnington Grove Veterinary Surgery and Michigan State University for their assistance in preparation of the study.

**12.10–12.25**
**Is arthroscopy superior to thorough-and-through lavage in the treatment of open synovial structures due to perforating trauma?**

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**Aims:** To provide a retrospective comparison of arthroscopy vs. thorough-and-through lavage in the treatment of perforating trauma to synovial structures. **Methods:** Over the period 2002–2009, 78 patients were treated for wounds with perforating synovial structures at the Utrecht University Equine Clinic. Of these, 61 patients were treated by thorough-and-through lavage and 17 patients were treated by arthroscopy of the affected synovial structure. Surgery was repeated if the synovial cavity was still contaminated, based on clinical status and synovial fluid analysis. History, clinical examination, diagnostic work-up, treatment and short and long-term outcome were compared for the different treatment groups. **Results:** The majority of the patients were treated within 8 h of injury (56.4%). Twelve patients were treated after more than 100 h following injury (15.4%). All horses were lame, but no horse was fracture lame (average grade 2.56 out of 5). The arthroscopically treated group needed significantly fewer surgeries than the thorough-and-through lavage group (P<0.005). 94.1% of the arthroscopically treated patients vs. 40% of the patients treated by thorough-and-through lavage needed only one surgery. On average patients needed 1.49 surgeries. Hospitalisation time did not significantly differ between treatment groups (P>0.005). The overall short term prognosis was excellent (93.6%). In the long term, 80.8% of patients were sound to be ridden. Lameness grade on referral and the time elapsed between trauma and initiation of treatment negatively affected prognosis. Also, if the coffin joint and/or the navicular bursa were involved, prognosis was significantly less favourable (P<0.005). Concurrent trauma like extensor tendon rupture or collateral ligament injury did not affect long-term outcome. **Conclusions:** In this case series, arthroscopic approach proved superior to thorough-and-through lavage in the treatment of wounds involving open synovial structures.

**12.25–12.40**
**Evaluation of coblation to perform palmar/plantar annular ligament desmotomy in the horse**

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**Aims:** To describe and evaluate the safe use of coblation to perform elective tenoscopic palmar/plantar ligament desmotomy in the horse. **Methods:** Case records were reviewed for horses undergoing elective digital sheath tenoscopy at the Liphook Equine Hospital between January 2007 and July 2009. Cases were included if they had annular ligament desmotomy (ALD) performed tenoscopically using an Arthrocare Saber 30° radiofrequency wand. The annular ligament was transected for treatment of conditions causing constringation through the fetlock annular canal. Short-term follow up information was obtained from hospital records and referring veterinary surgeons. Long-term follow-up information was obtained, at least 6 months post operatively, from hospital records, referring veterinary surgeon questionnaires and through telephone interviews with owners. **Results:** Forty cases of digital sheath tenoscopy, performed on 37 horses, were included. No intraoperative complications were recorded. Post operatively, complications recorded were transient discharge from an arthroscopic portal (2/40) and distal limb cellulitis (1/40). Long-term follow-up information was available for 35 horses. Twenty-four horses (69%) were sound at follow-up with 17 horses (49%) returned to a pre-injury level of work. **Conclusions and practical significance:** Minimally invasive ALD can be performed using coblation equipment under arthroscopic visualisation and through routine tenoscopic portals. The technique provides good control during transection of the annular ligament and coagulation of the tissues carries a low complication rate. Short- and long-term results suggest there are no deleterious effects to the digital flexor tendon sheath. Long-term outcome figures for soundness compare to those previously reported. **Acknowledgements:** Surgeons: D. Lloyd, T.K. Hughes, T.J. Phillips, J.P. Walmley. Twenty referring vets for providing cases and follow-up information.

**12.40–12.55**
**Use of ethanol in the treatment of distal tarsal joint osteoarthritis: 23 cases**

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**Aims:** To describe and evaluate the results of treatment of distal tarsal joint osteoarthritis with intra-articular ethanol injection. **Methods:** Twenty-three horses met the inclusion criteria of
diagnosis of tarsometatarsal and centrodistal joint osteoarthritis diagnosed by positive response to intra-articular analgesia, radiographic evaluation and being lame 4 months or less after intra-articular medication with corticosteroid. Horses were sedated and following a radiographic contrast study of the tarsometatarsal joint, medication with 3–5 ml of either 100% pure ethanol or a 70% ethanol solution made with sterile saline. A controlled exercise programme was followed and cases followed for a minimum of 4 months post treatment. Client satisfaction and follow-up examination was used to evaluate improvement. Horses were classified as improved or not improved based on a 50% reduction from initial lameness grade coupled with client-perceived improvement. Results: Of the 23 horses included in this study 21 had the treatment performed bilaterally and 2 unilaterally. 20 horses were available for lameness follow-up, 3 horses were retired or subjected to euthanasia for reasons not related to hindlimb lameness. 12/20 (60%) of horses were classified as improved following treatment. None of the horses (n = 4) treated with 100% ethanol improved, conversely 12/16 (75%) treated with 70% concentration improved. Localised swelling commonly occurred and resolved untreated within 5 days, more serious local reaction and soft tissue fibrosis may occur with significant periarticular injection. Conclusions and practical significance: Medication with 70% ethanol should be considered a safe and economic treatment for recurrent cases of distal tarsal joint osteoarthritis which fail to show long-term improvement to intra-articular corticosteroid. We highlight the importance of using a 70% solution and performing an adequate radiographic contrast study of the tarsometatarsal joint prior to treatment. Acknowledgements: We thank the staff at Dalehead Veterinary Group, The Minster Equine Clinic, Cambridge University and Cotts Equine Hospital.
Influence of allele copy number on severity of skeletal muscle phenotype in horses with type 1 polysaccharide storage myopathy (PSSM)

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Type 1 PSSM is an autosomal dominant condition caused by a missense gain of function mutation (R309H) in skeletal muscle glycogen synthase (GY51). Aims: To compare (i) resting plasma creatine kinase (CK) and aspartate aminotransferase (AST) activities and (ii) skeletal muscle pathology, between horses that are homozygous, heterozygous or negative for the R309H mutation. Methods: GYS1 genotyping of 107 horses was conducted using a validated restriction fragment length polymorphism assay. Resting serum CK and AST activities were compared between groups. Six age, breed and sex matched homozygotes (HH), heterozygotes (HR) and controls (RR) were selected, from which semimembranosis muscle samples were biopsied and frozen in isopentane. Cryosections were stained using haematoxylin and eosin for evaluation of muscle architecture. The percentages of fibres with internalised nuclei, subsarcolemmal and intracytoplasmic vacuoles were compared. Results: There was a significant difference in AST (P<0.001) and CK (P = 0.023) activities between the 3 groups (AST [mean ± s.d.]: HH = 502 ± 116 IU/l; HR = 357 ± 92 IU/l; RR = 311 ± 64 IU/l; CK median [interquartile range]: HH = 364 [332–764] IU/l; HR = 301 [222–377] IU/l; RR = 260 [216–320] IU/l), with increasing activity associated with the number of mutant alleles. There was a significant difference between the percentage of fibres with subsarcolemmal vacuoles (P = 0.002: HH mean = 35 ± 16%; HR = 20 ± 11%; RR = 0.2 ± 0.3%), cytoplasmic inclusions (P = 0.003: HH mean = 18 ± 22%, HR = 3 ± 4%; RR = 0 ± 0%) and diastase resistant inclusions (P = 0.003: HH mean = 8.9 ± 5.7%; HR = 2.9 ± 3.2%; RR = 0 ± 0%) between groups. Conclusions: Homozygotes have more severe skeletal muscle disease than heterozygotes with type 1 PSSM and subclinical pathology can be marked. Practical significance: Genotyping would allow noninvasive identification of the most severely affected horses and may be especially relevant in horses with elevated resting CK or AST activities.

Longitudinal monitoring of synovial fluid biomarkers over the first year of life in foals that do or do not go on to develop tarsocrural osteochondrosis

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Aims: To study the mechanisms and dynamics of tarsocrural osteochondrosis (OC) by monitoring temporal changes in biomarkers of cartilage turnover and growth factors in foal synovial fluid. Methods: Tarsocrural synovial fluid samples were obtained at ages 18, 22 and 52 weeks from n = 39 foals in an experimental study of OC. Samples were analysed for markers of type II collagen synthesis (CPII) and cleavage (C2C), proteoglycan turnover (CS846 and GAG), and growth factors IGF-1 and TGF-β1. Marker levels in foals that did or did not subsequently develop radiographic OC lesions at 5.5 or 11 months of age were compared over time using a linear mixed model. Results: CPII/C2C ratio was consistently higher in OC-affected joints compared to control joints, while CS846, CS846/GAG ratio and IGF-1 concentrations were reduced in OC-affected vs. control joints at 18 weeks of age only. Conclusions and practical significance: The consistent elevation of CPII/C2C ratio at all ages tested indicates an anabolic shift in type II collagen turnover in foals with OC that is not specific for a particular phase of the disease process. Aberrant proteoglycan turnover is not a hallmark of the repair phase, but reduced synthesis may be a feature of early still active lesions, as is a reduction in SF IGF-1 concentration. Our results corroborate the dualistic character of tarsocrural OC, with a highly dynamic and a stabilisation phase and a transition between the 2 at approximately 20 weeks of age. Longitudinal monitoring of SF markers in animals younger than 20 weeks may reveal more about the pathogenetic mechanisms of initial lesion occurrence in early OC. Acknowledgements: This study was part of a larger research programme funded by the French Stud and conducted by INRA. Sample collection was carried out at the experimental station of French Stud, 19340 Chamberet, France.
Diagnostic imaging of induced lesions of osteochondrosis in the distal femur of Norwegian Fjord Pony foals

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Aims: Describe the changes observed using contrast computed tomography (CT) and micro-computed tomography (micro-CT) to examine induced lesions of osteochondrosis in foals. Methods: The experimental protocol was approved by the National Animal Research Authority. The blood supply to the epiphyseal growth cartilage of the lateral trochlear ridge of the left distal femur was surgically interrupted in 9 Norwegian Fjord Pony foals aged 13–15 days old. The foals were sacrificed at 4, 7, 10, 14, 21, 28, 35, 42 and 49 days post operatively. Barium angiograms were created by perfusion of the femoral artery with micronised barium. The operated distal femora were examined using CT and micro-CT. The changes observed were validated by gross post mortem and histological examination. Results: Necrosis of interrupted vessels was seen in histological sections from all 9 foals. With contrast CT and micro-CT, abrupt termination of vascular contrast columns was seen. Vessel necrosis resulted in ischaemic chondronecrosis, but cartilaginous changes were not visualised with CT or micro-CT. Areas of ischaemic chondronecrosis caused focal delay in enchondral ossification in 5 foals. Delayed enchondral ossification appeared as focal indented contour, absence of the subchondral bone plate and subchondral radiolucency in CT and micro-CT scans. Revascularisation and reparative ossification of lesions was apparent in histological sections from some foals. Contrast CT and micro-CT could not resolve these processes to the same level as histological examination. Both processes were, however, visible, and on a millimetre scale, the spatial resolution of these processes was better with contrast CT and micro-CT than histological examination. Conclusion: The current results can be extrapolated to CT examination of live foals and enable longitudinal, in vivo validation of the ischaemic hypothesis for the pathogenesis of osteochondrosis. They can improve decision-making in the clinical management of mineralised irregularities in young horses. Acknowledgements: Norwegian Agricultural Purchasing and Marketing Co-Op.

Fatigue (stress) fractures in equine athletes are associated with increased metacarpal bone volume fraction


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Aims: To better understand how the processes of bone adaptation (modelling) and repair (remodelling) are involved in condylar fracture development in Thoroughbred racehorses. Methods: High resolution peripheral quantitative computed tomography (HR-pQCT) was used to measure the distal third metacarpal bones obtained at post mortem from 13 horses with condylar fractures of the third metacarpus (cases), 8 horses without fractures (training controls), 14 horses with fracture at another site (fractured controls) and 9 horses resting from training (resting controls). Results: Porosity of the distal metacarpal subchondral bone in cases was lower than resting controls (0.12 ± 0.014 vs. 0.18 ± 0.016, P = 0.017). Bone volume fraction (BV/TV) of the distal metacarpal epiphysis was greater in horses over 3 years of age than horses 2 or 3 years old (0.79 ± 0.01 vs. 0.74 ± 0.01, P = 0.016). BV/TV tended to be higher in horses with fractures than training controls (cases 0.79 ± 0.015 vs. training controls 0.74 ± 0.019, P = 0.07, and fractured controls 0.79 ± 0.014 vs. training controls 0.74 ± 0.019, P = 0.04). All condylar fractures occurred within areas of focal increased bone volume. Condylar fractures in younger horses occurred earlier in a training programme (rs = 0.75, P = 0.003) and at lower BV/TV than those in older horses (difference 0.05, P = 0.048). Conclusions and practical significance: In horses in race training, subchondral bone remodelling in the distal metacarpus is suppressed. Fatigue life is prolonged through adaptation by increased bone volume but this does not prevent condylar fractures, which often occur in the most adapted areas of bone. Previous modelling in the distal metacarpus is not specific for condylar fracture as it was also associated with fractures at other sites within the limb. Appropriate management of training and rest period duration may reduce the risk of fracture in racehorses. Acknowledgements: Supported by the Rural Industries Research and Development Corporation and Racing Victoria Limited.

Changes in the morphology of the laminar tissue after endotoxin addition to the perfusate in long-term perfused isolated equine

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Aims: To describe histological findings in laminar tissue of hooves exposed to endotoxins (ET) in blood perfused isolated equine forelimbs. Methods: Five distal forelimbs collected from 5 clinically healthy adult horses following slaughter at a licensed abattoir. The isolated limb was perfused under physiological conditions over 10 h with autologous blood. After the equilibration period of 30 min, Escherichia coli O55:B5 lipopolysaccharide (blood concentration 80 ng/l) imitating levels naturally occurring in endotoxaemic horses were added to the perfusate. Cell viability and metabolic parameters were closely monitored. After perfusion, semiquantitative light microscopic examinations of dorsal laminar tissue specimens were performed in 5 limbs. In 2 limbs the time until displacement or rotation of the pedal bone within the hoof capsule when loaded with 28% of the body mass was determined using a material testing machine. Histological analysis was carried out subsequently in these limbs. Results were compared with results obtained from similarly treated limbs without ET (3 nonloaded, non-ET limbs;
2 loaded, non-ET limbs. **Results:** Histological appearance of the laminar tissue in the nonloaded ET limbs showed marked vasodilatation without obvious oedema formation. Laminar changes typical of laminitis were seen in the 2 loaded ET limbs, with elongation of the lamellae and isolation of the basement membrane. Changes in the loaded non-ET limbs were less obvious. The overall time needed for displacement of the pedal bone within the hoof capsule was lower in the ET limbs compared to the non-ET limbs. **Conclusions:** Endotoxinaemia damages the laminar tissue in the perfused isolated equine limb, and weakens the suspension of the pedal bone within the hoof capsule.

**Practical significance:** In the absence of loading, endotoxinaemia does not produce laminitis like changes in perfused distal limbs. The use of slings should be encouraged in endotoxinaemic horses.

**14.45–15.00**

**Modulation of prostaglandin E<sub>2</sub> production in equine tendon cells**

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**Aims:** The mechanisms involved in tendonopathy are not fully elucidated although prostanooids such as prostaglandin E<sub>2</sub> (PGE<sub>2</sub>) are cited as mediators of tendon injury produced in response to numerous stimuli including repetitive motion. PGE<sub>2</sub> and pro-inflammatory cytokines such as Interleukin-1β (IL-1β) can initiate up-regulation of matrix metalloproteinases culminating in tendon pathological change. The purpose of this study was to investigate the effects of the nonsteroidal anti-inflammatory drugs Firocoxib (COX-2 selective inhibitor) and Indomethacin (nonsellective inhibitor), heterologous conditioned serum (HCS) prepared from irap® and Interleukin-1 receptor antagonist protein (IL-1RaP) on modulating PGE<sub>2</sub> production in tendon cells.

**Methods:** Tendon derived cells (TDCs) were isolated from macroscopically normal superficial digital flexor tendons from horses aged between 3 and 8 years. Monolayer cell cultures were stimulated with 10 ng/ml human recombinant Interleukin-1 beta (IL-1β) and cultured in the presence of either: 0.125 µmol/l Firocoxib, 20 µmol/l Indomethacin, 200 µl HCS, 10 ng/ml or 50 ng/ml IL-1RaP. Non-stimulated cells served as controls. After 24 h, media were harvested to assess PGE<sub>2</sub> production via radioimmunoassay.

**Results:** Addition of Firocoxib to stimulated cells resulted in up to 85% reduction in PGE<sub>2</sub> released in media and near complete inhibition was achieved with Indomethacin, suggesting that the residual PGE<sub>2</sub> in Firocoxib cultures was attributable to constitutive COX-1 production. Addition of either 50 ng/ml, 10 ng/ml IL-1RaP or HCS prepared from irap® reduced prostanooid production by 72, 40 and 30%, respectively. The volume of HCS added was limited by the total culture volume and may explain the partial inhibition with this preparation. **Conclusions and practical significance:** These antagonist compounds have potential therapeutic efficacy in the management of acute tendinopathy by modulating COX-2 mediated PGE<sub>2</sub> synthesis. Further investigation on MMP mediated matrix degradation and on fibrillar collagens and matrix protein production is warranted.

**Acknowledgements:** Stephanie Dakin is generously funded by the Betting Levy Board.

**15.00–15.15**

**Comparison of viral gene-delivery systems for myogenic conversion of equine skin-derived fibroblasts to multinucleated myotubes**

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Our group focuses on studying the pathophysiology of equine exertional myopathies; given the invasive nature and difficulty in obtaining muscle samples from affected horses and controls, we have recently developed a method to induce myogenic conversion of equine skin-derived fibroblasts, using a lentivirus that delivers a permanently-integrated muscle-specific transcription factor (MyoD-1) transgene. **Aims:** To compare the efficiency of adenoviral-mediated transient MyoD transgene expression with our existing lentiviral system, in myogenic conversion of equine and human skin-derived fibroblasts to myotubes, by examining infection efficiency, myotube fusion and differentiation.

**Methods:** Lentiviral and adenoviral particles expressing equine MyoD were generated after cloning equine MyoD. Equine and human skin-derived fibroblasts were transduced with different concentrations of each virus and incubated in differing media. Infection rate was assessed after 24 h by MyoD immunocytochemistry and after 6 days by desmin immunocytochemistry.

**Results:** Lentiviral particles infected equine and human fibroblasts with similar efficiency as reflected by similar percentages of MyoD positive cells 24 h after infection. However, our MyoD expressing adenovirus infected equine fibroblasts with higher efficiency than human fibroblasts at every dose tested. Both adenov- and lentiviral transduction resulted in similar conversion of skin equine fibroblasts to multinucleated desmin-positive myotubes. **Conclusions:** Both lentiviral and adenoviral systems expressing MyoD successfully induce myogenic transformation of equine fibroblasts. Adenoviral infection rates were higher in equine cells compared to human cells, probably due to differential expression of CAR (viral entry) receptor, through both species’ skin fibroblasts can be transformed into multinucleated myotubes using this system. **Practical significance:** Adeno and lentivirus-mediated myogenic conversion can be used with similar efficiency in order to generate cultured muscle cells which may prove useful in investigating the pathophysiology of equine muscle disorders such as recurrent exertional rhabdomyolysis and polysaccharide storage myopathy.

**Acknowledgement:** Financial support from the Horse Race Betting Levy Board is gratefully acknowledged.

**15.15–15.30**

**Can equine neck pain derive from synovial folds in cervical facet joints?**

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**Aims:** Synovial folds on the synovial membrane have been observed in the cervical facet joints of horses (Berg et al. 2003). But neither the morphological variation within horses nor the...
possible presence of nociceptive nerves has been studied. This is of clinical significance since innervated synovial folds could be injured by neck trauma. The aim of this study was to examine the morphology of synovial folds in equine cervical facet joints, and the possible existence of nociceptive nervous fibres in these folds.

Methods: Synovial folds were obtained from 6 horses, subjected to euthanasia for other reasons than facet joint disease, at the Faculty of Life Sciences. A total of 85 cranial and caudal synovial folds were measured in situ and excised from cervical facet joints C2 to C7 bilaterally. The synovial folds were fixed in 4% paraformaldehyde and embedded in paraffin. Sections were either stained by haematoxylin and eosin or subjected to immunohistochemistry using monoclonal antibodies against neuron specific β-III-tubulin and the neuropeptides Substance P (SP) and Calcitonin Gene Related Peptide (CGRP).

Results: The size of the synovial folds varied from 10–40 mm in diameter and lengthwise from 3–35 mm. Histologically, the synovial folds were consisting of adipose tissue or fibrous tissue or a combination of the 2. Immunoreactivity to β-III-tubulin, SP and CGRP was found in synovial folds from all 6 horses, suggesting the presence of nociceptive nerves.

Conclusions: The synovial folds do contain nociceptive nerves and the synovial folds are of a size that would allow them to get traumatised. Hence, cervical facet joint pain could derive from these folds.

References
15.45–16.00
High-field and low-field magnetic resonance imaging findings in the proximal aspect of the suspensory ligament in the forelimb of nonlame horses

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Aims: To describe high-field and low-field magnetic resonance imaging (MRI) appearance of the proximal aspect of the suspensory ligament (SL) in the forelimb of nonlame horses.

Methods: High-field and low-field MR images of the SL and surrounding structures of 30 cadaver forelimbs of nonlame horses were analysed subjectively and measurements were made at 4 levels.

Results: The palmar cortex of the third metacarpal bone was thicker medially than laterally (P<0.0001). Mild periosteal irregularity was recorded in 29/30 limbs. The medial and lateral aspects of the SL were identified at 2 and 3 cm distal to the carpometacarpal joint and merged between 5 and 7 cm. Additional fibres originated from the fourth metacarpal bone in all horses. At 2 and 3 cm distal to the carpometacarpal joint, the lateral lobe had greater cross sectional area than the medial (P<0.0001). The collagenous tissue had low signal intensity in all high-field T1-weighted images in 27/30, and in T2*-weighted images in 20/30 limbs. The signal intensity of the muscle and adipose tissue was intermediate to high and varied between limbs and MRI sequences. Mild irregularity of the margins of the SL was seen in 21/30 limbs at 3 cm distal to the carpometacarpal joint. The SL was surrounded by intermediate to high signal intensity connective tissue. Fine low signal intensity bands were seen in all limbs between the SL and the metacarpal bones and the accessory ligament of the deep digital flexor tendon. The medial palmar metacarpal neurovascular structures made assessment of the SL difficult in 27/30 limbs at least one level.

Conclusions: There was a large variability in the MRI appearance of the SL in nonlame horses, which should be considered when interpreting clinical MR images.

Acknowledgement: The Bransby Trust.

16.00–16.15
Do lesions to the deep digital flexor tendon (DDFT) in the foot identified on MR alter with time?

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Aims: To determine whether lesions to the deep digital flexor tendon (DDFT) in the foot identified on MR alter with time.

Methods: The MR images and clinical records of 306 MR examinations (low-field, 0.27T) at the University of Liverpool (August 2007–November 2009) were studied. Cases included were identified as having a primary DDFT lesion. Lesions were divided into longitudinal tear, dorsal tear, core lesion or full split. Volumetric analysis (cm³) were made using Visbion measurement software on T1w and T2*ow sagittal, transverse and frontal sequences. Follow-up scans were performed using the same weightings and sequences as the initial scan. Lesions identified at initial presentation were longitudinal tears (n = 4; 0.29 ± 0.08 cm³), dorsal tears (n = 7; 0.13 ± 0.03 cm³), core lesions (n = 6; 0.32 ± 0.13 cm³) and full splits (n = 8; 0.28 ± 0.04 cm³). Average lameness score at initial scan was 1.8 ± 0.3 (straight) and 3.0 ± 0.3 (circle). Follow-up examinations showed no significant difference in volume for longitudinal tears, core lesions or full splits but significant reduction in volume for dorsal tears (0.07 ± 0.02 cm³ (n = 7) and 0.04 ± 0.01 cm³ (n = 4), both P<0.01 c.f. initial scan) at first and second re-scans. Overall lameness scores improved at first scan (str. 0.5 ± 0.2; circ. 0.7 ± 0.2) but had slightly worsened by second re-scan (str. 0.7 ± 0.3; circ. 1.5 ± 0.6). Conclusions and practical significance: Dorsal tears show evidence of significant volume reduction which parallels clinical improvement over 6 month follow-up but longitudinal tears, core lesions and full splits do not appear to alter. Identification of DDFT lesion-type can provide valuable prognostic information for owners.

Acknowledgement: Hallmarq Veterinary Imaging Ltd.

16.15–16.30
A scintigraphic retrospective study of the prevalence of back and pelvic pathology in a population of UK racehorses

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Aims: To document the prevalence and intensity of scintigraphic abnormalities in the thoracic spine, lumbosacral spine and pelvis of UK racehorses; to compare these findings with the published literature and to consider why differences may have arisen.

Methods: Data were reviewed from 708 horses that underwent bone scan examination at Rossdales Diagnostic Centre between September 2007 and September 2009. Cases eligible for inclusion were Thoroughbred horses engaged in active training for flat or

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National Hunt racing. Images were examined subjectively by a single experienced clinician (M.H.). A thorough literature review was undertaken and compared to the results of this study. Statistical power calculations were performed to validate conclusions. Results: One-hundred-and-ninety-eight cases fulfilled the criteria for inclusion (171 flat; 27 NH). 90% of horses demonstrated increased radionuclide uptake (IRU) in one or more areas of the skeletal tissue imaged. Overall, there was a 51% prevalence of abnormal uptake in the dorsal spinous processes, a 14% prevalence of abnormal uptake in the articular facet joints and a 15% prevalence of abnormal uptake in the pelvis. No significant effect of age or sex was seen on the prevalence of IRU in any region of the spine or pelvis. Conclusions and practical significance: There was a noticeably lower prevalence of abnormalities in the back of the study population of racehorses compared to previous post mortem studies conducted in the USA (Haussler and Stover 1998; Haussler et al. 1999): this study is the first to document this difference. The work has important implications for the clinical assessment of racehorses, the interpretation of cadaver studies and the extrapolation of existing data derived from non-Thoroughbred populations. It implies potentially significant differences between clinical and subclinical prevalence of disease and the importance of training and racing conditions between racing jurisdictions/countries.

References

16.30–16.45
Intra- and inter-operator variability in sagittal ratio values obtained from cervical radiographs of horses with neurological disease


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Aims: To determine the intra- and inter-operator variability in intra- and inter-vertebral sagittal ratio value (SRV) measurements made from radiographs of horses with neurological disease for diagnosis of cervical vertebral stenotic myelopathy (CVSM).

Methods: For this retrospective study, archived digital cervical radiographs, clinical history, serological and CSF analysis results, and myelographic and post mortem reports of horses with neurological disease were gathered from 4 veterinary hospitals. From 23 sets of radiographs in DICOM format, 42 were selected for inclusion in the study (horse age: 1–18 years, 33 male, 9 female). Four operators experienced in examination of cervical radiographs made measurements from all 42 radiograph sets and intra- and inter-vertebral SRVs were calculated for C2-C7 inclusive to determine inter-operator variability. Ten sets of radiographs were randomly selected for re-measurement and calculation of SRVs 2 weeks later for determination of intra-operator variability. For all radiographs, electronic calipers were used to make measurements. Operators were blinded to clinical and outcome data of the cases. Bland Altman analyses were used to examine intra- and inter-operator agreement for each SRV. The degree of variation between 2 operators and within the same operator was also calculated as the percentage variation of the absolute SRV for each vertebral site. Results: Intra-vertebral SRVs were more repeatable and reproducible than inter-vertebral SRVs. Variation in inter-vertebral SRVs was greater for C2-3, C3-C4 and C4-C5 than other sites. Variation in both intra- and inter-vertebral SRVs was greater between operators than within operators. Conclusions and practical significance: The lower repeatability found with inter-vertebral SRVs, especially cranially, is of potential clinical importance and could affect the accuracy of diagnosis and influence case management. Variability in SRVs between operators has the potential to result in disagreement of diagnosis of CVSM. Acknowledgements: Funding was provided by the Wellcome Trust. Professors David Hodgson and Steve Reed.

16.45–17.00
Ultrasonographic anatomy of the equine thoracolumbar longissimus dorsi muscle

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Aims: Disorders of the equine back cause a variety of unspecific clinical signs, such as poor performance, reluctance to be ridden and secondary hindlimb lameness. The largest epaxial muscle, the thoracolumbar longissimus dorsi muscle (LD) is thought to play an important role in the pathogenesis of back problems. In man, ultrasonographic visualisation of muscle architecture and muscle size has been shown to be a very useful tool in the diagnosis and monitoring of lumbar back pain. The aim of this study was to demonstrate the ultrasonographic anatomy of the equine LD and adjacent anatomical structures in detail. Methods: Longitudinal and transverse ultrasound images of the back were acquired between T10 and L3 in set distances from the midline in 10 horses of different ages, breeds and fitness levels. The back of one Thoroughbred mare (subjected to euthanasia for reasons unrelated to this study) was frozen and band sawed in the planes corresponding to the ultrasound images. Results: The LD muscle shows the typical ultrasonographic appearance of skeletal muscle: hypoechoic muscle tissue interspersed with hyperechoic connective tissue, the ratio of which, however, varied between horses as does the angle and length of the muscle fibres. The LD has an internal fascia which is easily depicted as a hyperechogenic line ultrasonographically. Conclusion and clinical relevance: The LD has a complex architecture and detailed knowledge of its normal ultrasonographic appearance is necessary before pathological changes can be identified. This study provides a detailed atlas of the ultrasonographic anatomy of the LD which is a prerequisite for its use as a clinical tool.

17.00–17.15
Radiological abnormalities of the carpus of horses with lameness related to the carpus and control horses

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Proceedings of the 49th British Equine Veterinary Association Congress 2010 - Birmingham, United Kingdom
Aims: To describe radiological abnormalities of the carpus of horses of different disciplines; to compare these in horses with and without lameness originating from the carpal region. 

Methods: Two-hundred-and-eighty-six sets of carpal radiographs from 222 horses were analysed. Discipline and cause of lameness were recorded. Chi-square tests were used to test for associations between radiological findings and disciplines, and for associations between radiological findings and causes of lameness. 

Results: Abnormalities consistent with osteoarthritis of the antebrachiocarpal (ABC) and middle carpal (MC) joints were more severe in horses with lameness related to these joints than in nonlame horses, or horses with other causes of lameness (P<0.001). Six horses had modelling of the palmar aspect of the joint margins; all had signs of moderate or severe osteoarthritis dorsally. Mild osteoarthritis of the ABC joint was found in 92/286 (32.2%) of carpi and was a common finding in horses with and without lameness related to this joint. Osteoarthritis of the ABC joint was not associated with discipline. The prevalence of moderate or severe osteoarthritis of the MC joint was highest in racehorses (P = 0.019). Osteochondral fragments were found in 9/286 (3.1%) ABC joints and 14/286 (4.9%) MC joints. There were fragments on the palmar aspect of 10 joints which were associated with lameness and/or other fragments dorsally. Fragments in the MC joint were most frequently seen in racehorses (P = 0.017) and were associated with lameness and/or other fragments dorsally. Increased opacity of the third carpal bone was seen in 72/116 (62.1%) carpi and was most common in horses performing speed exercise (eventers and racehorses) (P = 0.036).

Conclusions: Radiological abnormalities were found in the carpus of horses of all disciplines; their significance was dependent on their severity and location. The entire carpus should be inspected carefully because lesions on the palmar aspect were all significant.

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Aims: To describe the radiographic anatomy of the distal tarsal joints following a single contrast injection into the tarsometatarsal joint (TMTJ) in standing sedated horses. 

Methods: Twenty-two horses diagnosed with distal tarsal joint osteoarthritis and undergoing medication for this condition were included. This corresponded to a total of 41 limbs. Iohexol (240 mg/ml) was injected into the TMTJ via a standard approach proximal to metatarsus IV until there was resistance to injection (3–5 ml). The contrast was maintained under pressure and one or 2 (DP or LM or DP and LM) radiographic views of the tarsus were taken. 

Results: Of the 41 TMTJs evaluated 29/41 (71%) showed evidence of communication with the centrodistal tarsal joint (CDTJ). Communication with the proximal intertarsal joint was seen in 2 limbs (5%). Contrast distribution in the joint revealed linear distal distribution along the axial aspect of MTIV for >1 cm from the level of the TMTJ in 22/41 (54%) limbs. 

Conclusions and practical significance: Standing radiographic contrast evaluation of the TMTJ is a useful technique and can be performed to assess the necessity to medicate the centrodistal tarsal joint separately. In cases where sclerosing agents are to be injected it can also assist in assessing the communication with the proximal intertarsal joint. Contrast distribution between the TMTJ and CDTJ is common and between the distal 3 joints is rare. Extension of the TMTJ latero plantar-distally can potentially affect the innervation to the distal limb (lateral plantar nerve and deep branch of the lateral plantar nerve) when performing intra-articular analgesia. Evaluation of a single radiographic view may be unreliable to evaluate joint communication. 

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09.00–09.15

Angiographic variation of the carotid trifurcation and the internal carotid arteries of donkeys

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Aims: To determine if there are variations in the anatomy of the internal carotid artery in both horse and donkey. Methods: Twenty-six donkey cadaver head and necks and 32 horse heads from animals aged between 2–15 years were collected with the guttural pouch and the carotid trifurcation intact. The specimens were subjected to angiography, arterial latex casting and dissection. Angiography was performed using a Ziehm Vision FD Vario 3D Image Intensifier. Results: Four distinct variations of the common carotid artery termination were identified as follows: (i) the internal carotid artery and the occipital artery arose as a common trunk, (ii) the external carotid artery was very short, giving the appearance of the common carotid artery terminating into 4 branches, (iii) the common carotid artery terminated into 4 branches with the origin of the internal carotid artery close to the carotid trifurcation, (iv) the origin of the internal carotid artery was not from the common carotid artery termination. Instead the internal carotid artery originated caudal to the common carotid artery termination. Conclusion and practical significance: This study showed that the carotid arterial tree of the donkey may differ greatly compared to the horse and that there is considerable variation between individual donkeys. Currently, there are scant anecdotrial reports of guttural pouch mycosis in the donkey. Anatomical variation may have a part to play in susceptibility to this disease. Furthermore a good understanding of the anatomy and its variation is crucial during surgery in this region.

Acknowledgements: The Donkey Sanctuary.

09.15–09.30

Clinical findings and diagnosis of aortopulmonary fistula in four Friesian horses

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Aims: To report the results of clinical examination, blood examination, cardiac ultrasound and cardiac catheterisation in 4 Friesian horses with an acquired aortopulmonary fistula due to aortic rupture. Methods: Four Friesian horses (age 1–7 years; 3 mares and 1 gelding) were presented at the university hospital for reasons of colic and tachycardia. Duration of the clinical signs varied from 6 h to 2 weeks. Results: All horses presented with sinus tachycardia (64–96 beats/min) with a marked bounding pulsation of the common carotid artery. Respiratory rate ranged between 24–80 breaths/min. A holosystolic and early diastolic murmur over the aortic valve was present in 2 horses. Abnormal haematological findings included mild anaemia and thrombocytopenia and an increased CK, LDH and cTnI. Thoracic radiography (n = 2) and ultrasound (n = 4) showed an increased diameter of pulmonary vessels and signs of pulmonary oedema in one horse and a small amount of thoracic fluid (n = 3). In all but one horse, cardiac ultrasound revealed fistulation of the aorta into the pulmonary artery with turbulent flow in the pulmonary artery, blood accumulation between both vessels (n = 2) and pulmonary wall dissection (n = 2). In all horses, cardiac catheterisation showed increased right heart pressures and pulmonary hypertension with increased pO2 and saturation in the distal pulmonary artery approaching systemic values (n = 3). One horse died after 10 h; the others were subjected to euthanasia after 1–7 days. Post mortem confirmed an aortopulmonary fistula near (but not at) the remnant of the ductus arteriosus in all horses. Conclusions and practical significance: Aortopulmonary fistula should be included in the differential diagnosis of colic combined with tachycardia. Friesian horses are predisposed to this condition of which diagnosis is made by thorough ultrasonographic examination and cardiac catheterisation. Horses may survive for several weeks but the condition is usually fatal.

09.30–09.45

Myocardial dysfunction in horses with acute abdominal disease

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Aims: To evaluate myocardial function in horses with acute abdominal disease. Methods: Eighteen clinically healthy horses and 69 horses with one of 3 categories of acute abdominal disease were studied: Strangulating obstruction, nonstrangulating obstruction or inflammatory disease. Heart rate, lactate, haematocrit and cTnI were measured at presentation. Fractional shortening (FS), left ventricular ejection time (LVET) and ECG were assessed in clinically healthy horses, the day after surgery in horses with intestinal obstruction and the day after presentation in horses with inflammatory disease. Proportions were compared using Fisher’s exact test and associations between values of cTnI, lactate and LVET in horses with abdominal disease were estimated using Spearman’s rank correlation coefficient (r). Results: The proportion of horses with elevated (>0.03 ng/ml) cTnI was significantly greater in horses with strangulating (0/25, 36%, P = 0.006) or inflammatory (9/19, 47%, P = 0.001) lesions compared to clinically healthy horses (0/18). The proportion of horses with elevated cTnI was not different in horses with...
nonstrangulating obstruction (4/25, 16%), compared to clinically healthy horses (P = 0.13) or horses with strangulating obstruction (P = 0.20). Cardiac troponin I was elevated in 9/40 (22%) survivors and 13/29 (45%) nonsurvivors (P = 0.068). Cardiac troponin I was associated with lactate (r = 0.43, n = 63, P = 0.0004) and LVET (r = -0.41, n = 25, P = 0.041). Conclusions and practical significance: Myocardial dysfunction occurs in horses with severe acute abdominal disease. Recognition of myocardial dysfunction could improve treatment of acute abdominal disease in horses. Acknowledgements: Racing Victoria and Rural Industries Research and Development Corporation for funding.

09.45–10.00
The impact of pneumonia during the first six months of life on subsequent racing performance in a cohort of Thoroughbreds

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Aim: This study was designed to examine the impact of pneumonia during the first 6 months of life on subsequent racing performance. Methods: A retrospective study of veterinary records, provided by a large Thoroughbred breeding operation was carried out. Content analysis was used to identify all horses born from 2000–2005, inclusive that had suffered from pneumonia during their first 6 months of life. The hypotheses were that foal pneumonia was associated with either a reduced likelihood of racing or, for those horses that did race, a reduced level of performance. Chi-squared tests were performed to identify if foal pneumonia was associated with the likelihood that horses would race at least once. Two-sample t tests or Mann Whitney tests were performed on a range of performance variables to identify associations between early foal pneumonia and subsequent racing performance. Results: From a total of 1200 foals, 56 (4.7%) individuals suffered a bout of pneumonia before 6 months of age. Of these, 64% (n = 36) raced at least once. In comparison, 67% (771/1144) of horses that did not suffer from pneumonia raced at least once (P = 0.22). Pneumonia contracted during the first 6 months of life was not associated with the number of career starts (P = 0.18), wins (P = 0.74) or places (P = 0.55). Nor was it associated with total career earnings (P = 0.90) or average (P = 0.85) or maximum (P = 0.93) Racing Post or Official Ratings. Conclusions and practical significance: There appears to be little impact of foal pneumonia on subsequent racing performance. This may be due to the high level of veterinary treatment these animals receive, which is successful in reducing the long-term impact of pneumonia. Acknowledgements: Funding was generously provided by the Beaufort Cottage Educational Trust.

10.00–10.15
Diagnosis of pulmonary abscesses in foals: Comparison of ultrasonographic and radiographic examination at early stage of the disease

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Aims: To show the diagnostic value of ultrasonographic and radiographic examination in abscess-forming pneumonia in foals. The main focus was to evaluate whether one or both of these techniques can be used to detect pulmonary abscesses under field conditions in an early stage of disease. Methods: Clinical and haematological examination as well as thoracic ultrasonography and radiography was performed on 61 foals on a stud with endemic Rhodococcus equi pneumonia. 19 foals were clinically healthy and showed no haematological and no ultrasonographical signs of pneumonia. In 42 foals clinical signs of a respiratory disease or haematological findings indicating an infection and at least one pulmonary abscess at ultrasonography were observed. Results: Radiographic evaluation revealed an abscessing pneumonia in 20 of the 42 sick foals. However a discrepancy was noted in the findings of pulmonary radiographs for signs of abscesses between 3 experienced equine internists. Finally a good match between radiological and ultrasonographical findings of abscesses was observed only in the central region of the lung. During the study it was noticed that thoracic radiography under field conditions is more time-consuming and more expensive than ultrasonography. Conclusion: Ultrasound examination seemed to be more sensitive for the diagnosis of abscess-forming pneumonia in the early state in foals.

10.15–10.30
In vitro effect of right-sided abduction and transection of the transverse arytenoid ligament on abduction of the left arytenoid cartilage during equine laryngoplasty

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Aims: To test the hypotheses that abduction of the right arytenoid cartilage reduces abduction of the left arytenoid cartilage, and that transection of the transverse arytenoid ligament (TAL) in combination with prosthetic laryngoplasty (PL) would minimise the effect of right arytenoid cartilage abduction on left arytenoid cartilage abduction. Methods: A standard PL technique was used to abduct both arytenoid cartilages of 6 larynges. The mean force required to maximally abduct the left and the right arytenoid cartilages of the 6 larynges was recorded (Fmax), and divided into 9 and 3 force levels for the left and right arytenoid cartilages respectively. Photographs were taken at every combination of force applied to the left and right arytenoid cartilages before and after TAL transection (TALT). Mean arytenoid angles and left glottic cross-sectional area were calculated. Tukeys post hoc tests were
used to determine differences with PL and TALT-PL. Longitudinal and transverse sections of the TAL obtained from 7 other larynges were examined histologically. **Results:** TALT and force on the right and left arytenoid cartilages significantly affected left arytenoid cartilage abduction (all $P<0.0001$). Left arytenoid cartilage abduction was significantly lower with PL alone than after TALT-PL ($P<0.001$). As the force applied to the right arytenoid cartilage was increased, a progressive decrease in left arytenoid cartilage abduction was seen ($P<0.0001$, multiple comparisons all $P<0.05$).

**Conclusions and practical significance:** Abduction of the right arytenoid cartilage; such as occurs immediately after swallowing or during strenuous exercise, reduces abduction of the left arytenoid cartilage, the effect of which is minimised by TALT. Abduction of the right arytenoid cartilage after swallowing may be a mechanism by which abduction of the left arytenoid cartilage is gradually lost after PL. Transecting the TAL when performing a PL may minimise the loss of abduction that often occurs in the immediate post operative period.
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11.00–11.15
Racing performance of UK racehorses following composite surgery of soft palate thermocautery and the laryngeal tie-forward procedure: a case controlled retrospective study

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Aims: To assess racing performance of Thoroughbred racehorses in the UK following a composite surgery of the laryngeal tie-forward procedure (LTF) and either oral thermocautery (OTC), or laser thermocautery (LTC), of the soft palate. Methods: The race earnings for all of the horses undergoing LTF, with concurrent OTC or LTC, were recorded for the 5 races pre- and post operatively. Age, sex and race-matched case controls were assigned to each case. Pre- and post operative race earnings were compared within and between case and control groups. Results: Forty-eight racehorses underwent LTF. Seventeen had concurrent OTC and the remaining 31 had LTC. Eleven horses were definitively diagnosed with DDSP using treadmill or overground endoscopy, the remaining 37 horses had only a presumptive diagnosis of DDSP. Initial examination of results suggested a trend for race earnings to decrease in the 2 races preceding surgery, compared to the previous 3 races, and then increase again following surgery. An overall improvement in earnings was shown in 54% of cases for the 5 races following surgery, compared to the 5 races preceding surgery. Statistical analysis, however, showed no significant difference in race earnings when comparing the earnings for the 2, 3 or 4 races preceding surgery with the earnings for the 2, 3 or 4 races following surgery (P>0.05). There was also no statistical significance shown when comparing earnings of cases and controls both pre- and post surgery.

Conclusions and practical significance: The results of this study revealed no significant difference in race earnings for racehorses following the composite surgery. However, a similar proportion (54%) of horses improved their individual earnings post operatively compared to many previously reported treatments for DDSP. Therefore LTF in combination with either OTC or LTC appears to be a reasonable option for treatment of DDSP in racehorses.

11.15–11.30
Causes of continued respiratory noise following prosthetic laryngoplasty

Compostella, F., Tremaine, W.H. and Franklin, S.H.

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Aim: To investigate the causes of continued respiratory noise during exercise in patients that have undergone laryngoplasty and test the hypothesis that inadequate left arytenoid abduction (LAA) may be related to an increased risk of right-sided laryngeal collapse (RLC). Methods: Twenty-nine cases (5 mares and 24 geldings) presented to the University of Bristol between 1995–2009 were included. All horses underwent a resting and exercise endoscopic examination. Three competent veterinarians subjectively assessed the laryngo-pharyngeal function on recorded endoscopies evaluating: 1) Grade of LAA (Dixon’s scale); 2) Presence/Severity of palatal dysfunction; 3) Presence/Severity of axial deviation of the aryepiglottic folds (ADAF); 4) Presence/Severity of axial deviation of the vocal folds (ADVF). A Chi-square test was used to examine associations between grade of LAA and presence of RLC (significance at P<0.05). Results: Mean age on presentation was 7.3 years (range 3–14) and athletic use included 7 eventers and 22 racehorses. A single respiratory problem was diagnosed in 21% of cases while 79% had a combination of abnormalities (ADAF, RLC). Fifty-four per cent of the horses had laryngoplasty (grade 5) occurred in 3/29 (10%) cases. Of the remaining horses 7 had grade 4, 7 had grade 3, 11 had grade 2 and 1 had grade 1 LAA. Twenty-five horses had previously undergone a left-sided ventriculocordectomy. However, ADVF occurred in 10/29 (34%) cases (1 left-sided, 2 bilateral and 7 right-sided). Palatal dysfunction was observed in 23/29 (79%) cases and ADAF occurred in 19/29 cases (66%) (11 bilateral and 8 right-sided). There was no statistically significant association between degree of LAA and presence of RLC (P = 0.76).

Conclusions and practical significance: Multiple causes of dynamic airway collapse have been identified in association with continued respiratory noise in horses following laryngoplasty. However, there was no association between the degree of LAA and RLC. Acknowledgements: The Horse Trust.
Saturday 11th September 2010

Intermittent ER occurred during inspiration in all 5 horses and in 2 cases the epiglottis retroverted beyond the arytenoid cartilages. Frequency of ER increased with speed in all horses and was exacerbated by flexion of the neck in the 3 sports horses. Conservative treatment (in the form of increasing the level of fitness) was attempted in one horse. Eight months after the diagnosis, it continued making an inspiratory noise. Surgical treatment (comprising of resection of the subepiglottal mucosa) was attempted in another horse. However, it never raced after the procedure. The other 3 horses were retired.

**Conclusions:**
Epiglottic retroversion can affect adult horses (age >4 years) and prognosis for athletic performance is poor. **Practical relevance:**
Epiglottic retroversion appears not to be a congenital disease. We identified speed and neck position as aggravating factors. The low number of horses in our case series however prevented us from making any conclusions about predisposing factors. Further studies with larger number of cases will be required to identify risk factors and understand the pathogenesis of this rare condition.

**11.45–12.00**

**Intralesional Mitomycin C for the treatment of periocular sarcoids**

**Malalana, F., Morgan, R.A., Knottenbelt, D.C. and McKane, S.A.**

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**Aims:**
Sarcoids are the commonest skin tumour in the horse. There are many suggested treatments but no single therapy is universally effective. Radiation brachytherapy is considered the gold standard for treatment of periocular sarcoids, but it carries both financial and safety implications. The purpose of this study was to assess the efficacy of the chemotherapeutic agent Mitomycin C injected intralesionally for the treatment of periocular sarcoids, but it carries both financial and safety implications. The purpose of this study was to assess the efficacy of the chemotherapeutic agent Mitomycin C injected intralesionally for the treatment of periocular sarcoids.

**Methods:**
Four horses, one of them affected bilaterally and 2 donkeys with periocular sarcoids (n = 7) were treated with intralesional Mitomycin C. The horses received 2 courses of intralesional Mitomycin C 7 days apart. Each course consisted of 5 injections of 0.02% Mitomycin C every other day. In addition, 2 other periocular sarcoids in one horse and one donkey were treated in the same way and then surgically removed, and histopathology was performed, including proliferation (PCNA) and apoptosis (caspase 3) markers to assess the efficacy of the therapy.

**Results:**
All the sarcoids treated showed marked regression of the tumour over the following months (4 months on average) and none of them has shown signs of recurrence to this date. In the lesions surgically removed the ratio of mitosis vs. apoptosis (proliferation/regression ratio) indicated a regression of the tumoral process.

**Conclusion:**
These results show that intralesional Mitomycin C is a promising new therapy for the treatment of periocular sarcoids. **Practical significance:**
Intralesional Mitomycin C could become an alternative form of treatment for periocular sarcoids when other types of therapy, such as radiation brachytherapy, are not available. **Acknowledgements:** We would like to thank The Horse Trust for their support to this project.

**12.00–12.15**

**Ocular disease among working equines in Ethiopia**

**Scantlebury, C.E., Pinchbeck, G.L., Knottenbelt, D.C., Akilu, N., Gebreab, F., Zerfu, A., Yimeska K., Gemelchu, G. and Reed, K.**

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**Aims:**
To estimate prevalence and characterise ocular disease among working equines in Ethiopia. **Methods:**
One-hundred-and-fifty horses were randomly selected from each of 7 SPANA clinics in Ethiopia. All had an ophthalmic examination and owners completed a short questionnaire. Eye pathology was graded; 0 = normal eye, 1 = mild pathology affecting one structure, 2 = corneal ulceration, 3 = severe pathology involving multiple structures and/or pain, 4 = chronic, end stage eye, and a diagnosis recorded. The overall prevalence of abnormalities per eye examined was calculated adjusting for clustering at both horse and town level. **Results:**
A total of 1049 horses were included over one year. Most were cart horses (96.3%) and male (99%) of which 89.6% were geldings. The median age was 15 with significantly younger animals at one site. The overall prevalence was 23.5% (95% CI 21.7, 25.3 n = 454) which varied between towns (range 16.7–39.3%). Visual deficits were present in 51.8% while 30.8% had ocular discharge and 27.1% demonstrated ocular pain. Abnormalities in the right were over-represented compared to the left eye (OR 1.4 95% CI 1.1, 1.7 P<0.001).

Grades 1 and 4 were most common and 107 horses (23.6%) had bilateral pathology. Over a third (37.1%) of horses were purchased with eye disease, and these were more likely to have grade 4 lesions (P<0.001). Only 1.9% presented for assessment of eye disease and few had received any previous treatment (2.2%). Of 66 owners reporting a specific incident, 36 named traumatic injuries as the cause. **Conclusions:**
Prevalence of ocular disease is high in this population but treatment is not often sought despite these being working animals. The asymmetric distribution may be due to whip injuries or foreign bodies acquired while working on dirt roads. **Practical significance:** This study highlights a significant welfare issue and the need for greater owner awareness including early recognition, and availability of appropriate treatment.
12.15–12.30

Effects of enteral magnesium sulphate and psyllium on evacuation of large accumulations of sand from the ventral colon of horses

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Aims: To compare the effect of enteral administration of magnesium sulphate (MgSO₄), psyllium, and a combination of MgSO₄ and psyllium on the evacuation of large accumulations of sand in the ventral colon of adult horses and to document any side effects associated with treatment.

Methods: Twenty horses with large sand accumulations identified on abdominal radiography were selected for the study. Each horse was randomly allocated to one of 3 treatment groups: 1 g/kg bwt psyllium (Group P); 1 g/kg bwt MgSO₄ (Group M); and 1 g/kg bwt MgSO₄ combined with 1 g/kg bwt psyllium (Group PM). Treatments were administered daily as a 7% solution via nasogastric intubation and continued for a total of 7 days, or until sand was no longer visible on radiography. The amount of sand in the ventral colon of each horse was estimated by determining the cross-sectional area of sand (cm²) visible on lateral radiographs and the percentage reduction in cross-sectional area before and after treatment was determined for each horse.

Results: Four/5 (80%) of horses in group PM evacuated all the sand from the ventral colon within 7 days of treatment and the percentage reduction in cross-sectional area of sand ranged from 64–100%. In comparison, 5/8 (62.5%) horses in group P; and 4/7 (57%) of horses in group M evacuated all sand from the colon and the percentage reduction in these groups ranged from 14–100% and 33–100%, respectively. No significant side effects were seen in any of the treatment groups.

Conclusions and practical significance: This is an ongoing study; however, the preliminary data suggests that a combination of MgSO₄ with psyllium appears to be the most effective treatment for removing large accumulations of sand from the ventral colon of horses.
Clinical and laboratory data of horses with intestinal hyperammonaemia

**Dunkel, B., Chaney, K.P., Dallap-Schaer, B.L., Pellegrini-Masini, A., Mair, T.S. and Boston, R.**

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**Aims:** Intestinal hyperammonaemia (HA) has been infrequently reported in individual horses; however, there have been no studies describing clinical and laboratory data as well as short- and long-term outcome in a larger number of cases. **Objectives:** To describe clinical and laboratory data and short- and long-term outcome in a large group of horses with intestinal HA. **Methods:** Multi-centred, retrospective study: case records of horses with HA were reviewed and any horse with a clinical or post mortem diagnosis of intestinal HA was included. Horses with a diagnosis of primary hepatic disease were excluded. Relevant data were recorded and, if appropriate, data from survivors was compared to nonsurvivors to identify potential prognostic indicators. **Results:** Thirty-five cases, 25 adults (mean age 12.0 ± 5.3 years) and 10 foals and weanlings (3 >1-day old, 3 between 1 day and 1 month old and 4 foals 1–9 months of age) with intestinal HA were identified. Case histories included diarrhea, colic and neurological signs and the most common clinical diagnosis was colitis and/or enteritis. The most common clinical and laboratory abnormalities included tachycardia (mean heart rate 80 ± 25 beats/min; range 44–140 beats/min), increased packed cell volume (mean 49 ± 9%; range 31–66%), hyperlactataemia (mean 8.3 ± 5.8 mmol/l; range 1.9–19.8 mmol/l) and hyperglycaemia (mean 8.4 ± 3.1 mmol/l; range 1.8–17.8 mmol/l). Thirteen horses (37%) survived to discharge. NH₄⁺ concentrations on admission were significantly (P = 0.025) higher in nonsurvivors (492 ± 289 µmol/l; min–max 69–1079 µmol/l) compared to survivors (203 ± 164 µmol/l; min–max 60–496 µmol/l) and NH₄⁺ concentration on admission was the only parameter significantly associated with survival. All surviving horses and foals for which follow-up information was available recovered completely and returned to their intended use without complications. **Conclusions and potential relevance:** Intestinal HA occurs in adult horses and foals and is associated with severe clinical and laboratory abnormalities; further studies are required to investigate predisposing factors and delineate possible differences in aetiologies.

The clinical and pathological features of primary gastric impaction

**Mair, T.S. and Bird A.R.**

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**Aims:** Primary gastric impactions (unassociated with liver disease) are poorly described in the veterinary literature. The aims of this study were to retrospectively review the clinical and, where appropriate, pathological features of 10 cases of primary gastric impaction. **Methods:** The clinical details of all horses presenting to Bell Equine Veterinary Clinic with colic over a 5.5 year period were reviewed and cases of primary gastric impaction selected. Clinical and clinical-pathological data and results of pathological examinations were recorded. Follow-up data from those horses surviving to discharge were obtained via telephone questionnaire. **Results:** Ten cases of primary gastric impaction were recorded during the study period (1.3% total number of horses hospitalised for colic). Diagnosis was achieved on the basis of the results of ultrasonographic examination, rectal examination, gastroscopy and/or exploratory laparotomy. Four/10 horses were successfully treated and discharged from the hospital, 4/10 were subjected to euthanasia (3 at surgery and 1 due to recurrence of impaction) and 2/10 died. Three/10 horses had spontaneous gastric rupture despite attempted treatment. A post mortem examination was performed on all horses which died or were subjected to euthanasia; 3/6 had evidence of gross muscular hypertrophy of the stomach wall. **Conclusions and practical significance:** Primary gastric impaction is an unusual but important cause of colic. Affected horses can present with recurrent, chronic or acute colic. Spontaneous gastric rupture may occur in some cases. A proportion of affected horses have gross hypertrophy of the muscular layers of stomach wall, but whether this is a cause or an effect of primary gastric impaction is currently uncertain. **Acknowledgements:** Colleagues at Bell Equine Veterinary Clinic.

Gastric lesions in foals before and after weaning: influence of omeprazole

**Dahlkamp, M. and Venner, M.**

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**Aim:** To show the prevalence of gastric lesions and the development of bodyweight of weanling foals before and after weaning and to evaluate the effect of treatment with omeprazole on gastric findings after weaning. **Method:** Weanlings (n = 79) (5–7.5 months) were examined in 2 studies with about 40 foals each. Each study had 2 randomly formed groups of 20 foals, treatment group and control group. In the first study the foals...
received omeprazole 2.2 mg/kg bwt s.i.d. by oral administration of Gastroguard®. Foals of the second study received 4 mg/kg bwt s.i.d. of omeprazole via feeding, to avoid the stress of daily catching and oral administration. The control groups remained untreated. On Days -1 and 14 after weaning BCS and bodyweight were determined and foals were gastroscoped. The nonglandular, glandular and pyloric region were scored separately. Results: There were no significant differences between groups regarding weight and BCS. Of 79 foals, 46 (58%) had gastric lesions in one or more sites before weaning, (nonglandular portion: 28/46, glandular portion 14/46, pylorus 4/46). Controls of both studies showed significantly worsening only in the nonglandular portion. Both treated groups showed significant worse findings in the glandular and/or pyloric region on Day 14. There was a significant improvement in the nonglandular portion and a significant worsening in the glandular portion and the pylorus in the treated groups. Conclusion: Omeprazole at 4 mg/kg bwt s.i.d. via feeding is effective to prevent and treat ulcers of the nonglandular portion. Nevertheless omeprazole seems to have an impact on ulcerogenesis at the pylorus. Practical significance: Therefore the generalised prophylactic use of omeprazole in weanlings cannot be recommended. Factors that stimulate ulcerogenesis at the pylorus and the potential negative influence of omeprazole on the glandular mucous epithelium in foals should be identified.

14.45–15.00
How does a change from a pastured to a stabled regime affect water drunk, faecal output, faecal water content and large intestinal motility in the horse?

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Aims: To investigate the effects of transferring horses from a pastured to a stabled regime on large colon motility and water balance. Methods: Eight horses that were maintained under a standardised regime were monitored during a period of transition from pasture to stabling. Horses were monitored for one week at pasture, then transferred to a stabling regime (stabled, exercised, fed hay). Data was collected continuously for the first 7 days for stabling, and then every other day for another 7 days. All monitoring was noninvasive and management changes were part of the normal regime of the establishment. Daily water drunk, faecal output and faecal dry matter were recorded. Motility of the caecum, cecal flexure and pelvic flexure was measured at set times twice daily using transcutaneous ultrasound. Data was analysed using multilevel modelling (MLwiN 2.10). Results: The frequency of intestinal contractions was significantly decreased (P<0.05) in all regions of the large colon on Day 2 post stabling and in the pelvic flexure on Day 5. Horses drank significantly more water while stabled across all days than when they were pastured (P<0.05). Average water drunk while pastured was 25.88 ml/kg bwt/day and 63.59 ml/kg bwt/day while stabled. Faecal output was significantly lower across all days while stabled (P<0.05) especially in the first week of stabling horses. Average faecal output while pastured was 45.92 g/kg bwt/day and 17.9 g/kg bwt/day while stabled. There appeared to be an inverse association between faecal output and water drunk. Conclusions: Aspects of normal large intestinal function are affected in the first 2 weeks after a change in management. Practical significance: This study gives an insight into a possible mechanism for the development of impaction colic after a management change. This could be used to identify a risk period for impactions that could be beneficial when applying preventative measures. Acknowledgements: The Defence Animal Centre, Melton Mowbray; World Horse Welfare; The Welcome Trust.

15.00–15.15
Investigation of an alternative laparoscopic full thickness intestinal biopsy technique in the horse

*O’Meara, B., 1Lischer C.J., Philbey, A.W. and *Pollock, P.J.P.

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Aims: To investigate the requirements of a one step laparoscopic instrument to obtain full thickness biopsies from intestine. To investigate a novel biopsy excision technique (BET) and assess the histological quality of the biopsy excised as compared to a gold standard biopsy. Methods: The requirements of a laparoscopic instrument to obtain full thickness intestinal biopsy were identified. These aims were used as factors to which the potential of different BET were assessed by a scoring system. A boarded histopathologist assessed the quality of all the histological samples and graded the biopsy quality from 1 = excellent, 2 = very good, 3 = good, 4 = acceptable, 5 = poor, 6 = very poor. The optimal BET was then adopted as part of a prototype biopsy instrument. The prototype BET was used to obtain 30 biopsies from the distal jejunum and ileum of 3 horses which had been subjected to euthanasia for reasons unrelated to abdominal disease. The histological quality of the biopsy samples were assessed and scored. Results: The optimal excision shape and technique for use in a laparoscopic instrument was a U shape used in a ‘chopping board-like’ technique (CBT). The average quality score of the biopsy obtained by the prototype instrument was 3.46 (5 biopsies scored very good, 12 scored good, 6 scored acceptable and 7 scored poor). A lack of mucosa or disruption of the mucosal layer was the most common reason for down grading of samples. Myenteric ganglia and submucosal ganglia were present in 19 biopsy samples. Conclusions and practical significance: The U shaped BET used as part of the CBT excision technique has the potential to be used as part of a laparoscopic instrument to obtain full thickness biopsies from the intestine as part of a standing and solely laparoscopic procedure which may aid in the diagnosis and subsequent treatment of Grass Sickness.
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Comparison of complication rates between three different methods of castration

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Aims: Despite equine castration being a commonly performed procedure in practice, complications are common. The aim of this study is to directly compare complications and their frequency with 3 different methods of castration. Methods: Prospective study comparing recumbent open, inguinal closed and scrotal closed methods. Each horse was randomly allocated to a group. Group 1 (n = 20) castrated under general anaesthesia via an inguinal approach with primary skin closure; Group 2 (n = 20) castrated under general anaesthesia via the scrotal approach with primary skin closure; Group 3 (n = 20) castrated in recumbency via an open scrotal approach. All cases received a standard protocol for pre- and intraoperative medications and anaesthesia. All owners were asked to follow a standard post operative care protocol. Follow-up of cases was performed by a telephone questionnaire 14, 28 and 90 days post operatively. Complications were divided into 4 groups at the time of each questionnaire: no complications; mild complication which owner treated with no veterinary advice; moderate complication where owner sought veterinary advice; severe where a veterinary surgeon was required to examine and treat the horse. Results: Complications were seen with each method of castration. Initial results suggest a higher rate of severe post operative swelling with closed techniques. Omental prolapse occurred in one horse castrated by the open technique. Conclusion and practical significance: Castration complications requiring veterinary attention are more common with a closed approach with primary skin closure when compared to the open approach. However, life threatening complications are more likely to result following castration by the open technique. Complications following castration have medical and financial consequences and whilst it is important to recognise and treat complications early, further work is needed to identify risk factors predisposing for complications.
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16.15–16.30
Role of thymic stromal lymphopoietin in equine insect bite hypersensitivity
Janda, J., Klukowska-Rötzer, J., Heimann, M., Torsteinsdottir, S. and Marti, E.
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Aims: Insect bite hypersensitivity (IBH) is an allergic skin reaction to bites of Culicoides midges. It is mediated by T helper-2 (Th2) cells and allergen-specific IgE antibodies, but the mechanisms involved in the induction of Th2 response in horses are not clear yet. In mice and humans, thymic stromal lymphopoietin (TSLP) has been shown to induce Th2 differentiation and allergic dermatitis. The role of TSLP in equine allergies is unknown. The aim of the study was to determine the expression of TSLP in the skin of horses with IBH and to identify possible cellular sources of TSLP.
Methods: Therefore, we identified and sequenced the putative equine TSLP gene and established quantitative RT-PCR to assess TSLP expression. We assessed TSLP expression in lesional and nonlesional skin biopsies from 21 IBH-affected and 10 healthy Icelandic horses. In order to identify possible cellular sources of TSLP, we measured TSLP expression in peripheral blood leucocytes and in skin explants after stimulation with allergen (Culicoides extract), calcium ionophore, IgE-cross-linking and toll-like receptor (TLR)-ligands. Results: TSLP expression was higher in lesional skin of IBH-affected horses compared to skin of healthy horses (P<0.05). Peripheral blood leucocytes strongly up-regulated TSLP expression after stimulation with Culicoides extract, calcium ionophore and IgE-cross-linking. Since IgE-cross-linking was involved, we propose basophils to be possible sources of TSLP in peripheral blood. Skin explants upregulated TSLP expression after stimulation with Culicoides extract and TLR-ligands poly-I:C and lipopolysaccharide. Whether keratinocytes are the main source of TSLP in the skin will have to be determined by further studies.
Conclusions and practical significance: We identified TSLP as a potentially important cytokine in the development of IBH. TSLP expression was increased in lesional skin of IBH-affected horses, and stimulation of blood leucocytes and skin explants with allergen extract resulted in upregulation of TSLP.

16.30–16.45
Variation in plasma adrenocorticotropic hormone concentrations with season in the United Kingdom in clinically normal horses and ponies, and those with pituitary pars intermedia dysfunction
Copas, V.E.N., Durham, A.E. and Newton, J.R.

16.45–17.00
Faecal carriage of antimicrobial resistant Escherichia coli in recently hospitalised and nonhospitalised horses
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Aims: To investigate carriage of antimicrobial resistant commensal E. coli in the faeces of recently hospitalised and nonhospitalised horses and identify risk factors associated with the presence of resistance. Methods: Faecal samples were collected at weekly (for 4 weeks), and then monthly (for 4 months), intervals from 30 horses with previously identified antimicrobial resistant faecal E. coli. Fifteen of these horses were recently discharged from an equine hospital and 15 were horses from the community. Antimicrobial resistant E. coli cultured from the samples had their
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Foaling patterns at two Standardbred studs in the Southern hemisphere

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Aims: The aim of this study was to examine the foaling patterns of Standardbred mares foaling outdoors at studs at latitude 45 degrees south.

Methods: Data were collected prospectively by stud masters at 2 commercial Standardbred studs, generating 222 reproductive records and 439 foaling records. Data were transcribed, recorded into a customised MS Access database and examined for normality; descriptive statistics were performed using SPSS v17 (SPSS Inc, Chicago, Illinois, USA).

Results: The average gestation length was 349 ± 10 days. Service date and foaling date both had a significant effect on gestation length ($r^2 = 0.598$ and $r^2 = 0.248$, $P<0.001$) with gestation length decreasing with later service or foaling dates. The timing of the parturitions was bimodally distributed with the primary peak around 02.00 h and a secondary smaller peak (29% of all foalings) around 13.00 h. There was a significant difference ($P = 0.004$) between the 2 studs in the percentage of mares foaling between sunrise and sunset (37 vs. 24%) There was no significant effect of age, parity, time to pass placenta, time for foal to stand, or days to get back in foal associated with daytime or nighttime foaling.

Conclusions and practical significance: Gestation length of mares in this study was longer than in previous reports. The longer gestation length means decreased time available for these mares to get back into foal in the same season. It is important that management factors take this into account and ensure optimum conditions for conception; foal heat breeding may be essential. There were more mares foaling in daylight hours than has previously been reported. Under these conditions mares should be monitored for foaling during daytime as well as at night.

Acknowledgements: Macca Lodge and Kina Craig Studs, New Zealand.
resistance profiles determined. Multilevel logistic regression was used to examine relationships between predictor variables and the risk of resistance. Results: In total 225 samples were collected; antimicrobial resistant *E. coli* were found in 75.1% of samples, with a prevalence of 36.4% for multidrug-resistant (MDR-resistant to 3 or more antimicrobial classes) *E. coli* and 15.5% for extended-spectrum β-lactamase (ESBL)-producing *E. coli*. The prevalence of antimicrobial resistant and MDR *E. coli* was similar for both groups, but the prevalence of ESBL-producing *E. coli* was significantly higher in samples from recently hospitalised horses (*P* < 0.05). Multilevel, multivariable analysis showed antimicrobial treatment within the previous 4 weeks was associated with significantly increased risk for faecal carriage of MDR *E. coli*, and hospitalisation within the previous 8 weeks with increased risk of ESBL-producing *E. coli*. Conclusions and practical significance: Recently hospitalised horses have a significantly higher prevalence of ESBL-producing *E. coli* than horses in the community. Antimicrobial treatment and hospitalisation were associated with increased risk for faecal carriage of multidrug-resistant and ESBL-producing *E. coli*, with the effect of hospitalisation persisting for a relatively long period. Awareness of potential risk factors may enable reduction of the resistance seen in *E. coli*, decreasing the potential for transfer of multidrug-resistance to pathogenic bacteria. Acknowledgements: Bransby Home of Rest for Horses, DEFRA.

17.00–17.15

**Prospective study of haemodynamic disorders measured by echocardiography and associated with endotoxaemia in horses**


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**Aims:** The aim of the study was to assess the impact of endotoxin shock on equine cardiac function using echocardiography. **Methods:** Fifty horses admitted to the clinic with signs of endotoxaemic shock and 17 healthy control horses were submitted to a Doppler echocardiographic examination. The endotoxaemic horses were classified in 4 groups according to their shock score (1.00–1.25; 1.26–1.49; 1.50–1.75; 1.76–2.00). **Left ventricular (LV) echocardiographic and Doppler parameters** were compared between the 5 groups using a multivariable ANOVA analysis. **Results:** The LV internal diameter, ejection time, HR-corrected ejection time and HR-corrected mean velocity of circumferential fibre shortening, the aortic velocity time integral and deceleration time, and the stroke volume were significantly lower, whereas the HR and the peak velocity of the late diastolic filling of the mitral Doppler flow and its velocity time integral were significantly higher in grade 2–4 endotoxaemic horses than in control horses. Because of tachycardia compensating the lower stroke volume in endotoxaemic horses, the cardiac output was not significantly different between groups. The increased HR, the fall in preload and a probable decrease in afterload played a role in the observed changes in endotoxaemic horses. **Conclusion and practical significance:** The results of this study suggest an impaired systolic and diastolic LV function in horses with moderate to severe endotoxaemia. Doppler echocardiographic monitoring of the cardiac function could therefore be of interest in equine intensive care.

17.15–17.30

**MRSA prevalence in healthy horses in the Netherlands: a follow-up study**

**Jonquiere, F., van Duijkeren, E., Wagenaar, J. and Sloet van Oldruitenborgh-Oosterbaan, M.**

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**Aims:** Methicillin resistant *Staphylococcus aureus* (MRSA) is considered to be an increasing problem in hospitalised horses in the Netherlands. In 2008, 24 of 259 horses admitted to a veterinary hospital tested positive (Van Duijkeren et al. 2009), while in a study in 2005, 200 randomly selected ostensibly healthy horses all tested negative for MRSA (Busscher et al. 2006). This raised the question as to whether the high percentage of MRSA-positive horses reflected an overall increase in the population or was a product of the selection of the referral horses. The aim of the present study was to perform a follow-up screening of the 200 horses tested previously in the 2005 study. **Methods:** Of the horses screened in 2005, only 48 were still accessible (11 different premises). These horses were sampled with an additional 54 horses selected randomly at 6 other premises. Two nasal swabs were collected from each horse and incubated in 2 different selective media: one method similar to the study in 2005 (Busscher et al. 2006) and one more sensitive method that is now used as a standard and has been used in the study of the referral horses (Van Duijkeren et al. 2009). **Results:** All 102 horses tested negative for MRSA using both isolation methods. **Conclusion:** No MRSA was found in the 102 healthy horses tested in the Netherlands. Further studies are needed to establish whether specific risk factors for testing MRSA-positive can be identified in the group of referred horses.

**References**


Clinical Research Poster Presentations

Design and validation of an equine nerve block simulator

**Smith, A.L., Lowe, J. and Weller, R.**

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**Aims:** Diagnostic analgesia is one of the most valuable tools available to a clinician to localise equine lameness. Current teaching of equine nerve blocks to undergraduate veterinary students is based on the use of cadaver practical sessions and lectures. As undergraduate student numbers rise there are increasing limits on teaching time and cadaver availability. The aim of this study was to design and validate a nerve block simulator aimed at undergraduate veterinary students. It was hypothesised that there will not be significant difference in nerve block simulator trained students and traditionally trained students in their ability to correctly perform nerve blocks. **Methods:** The simulator was built using an equine forelimb skeleton built up to a realistic shape with foam. Metal discs were placed on the limbs as targets for the blocks and connected into an electronic circuit. The circuit is completed when the student places the needle onto the target causing a buzzer to sound, providing instant feedback to the student. The simulator includes the 3 most commonly performed forelimb nerve blocks, the palmar digital block, abaxial sesamoid block and low 4 point block. The simulator was validated by comparing 10 simulator trained students to 12 traditionally trained students in their ability to perform the 3 nerve blocks. **Results:** The traditionally trained group achieved a median of 13.67/18 correct blocks compared with 8.9/18 for the simulator trained group, thus the traditionally trained group performed significantly better than the simulator trained group (P<0.05). **Conclusion and practical significance:** Although the simulator trained group were outperformed by the traditionally trained group the simulator training was still beneficial. The design is relatively easy and inexpensive and hence provides a cost-effective method to allow training to practice nerve blocking without tutors.

Assessment of the impact of a charity training programme on health and welfare of working horses in Lesotho

**Upjohn, M.M., 1Lerotholi, T., 2Attwood, G. and Verheyen, K.L.P.**

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**Aims:** To assess the impact of an equine charity’s training programme on the health and welfare of working horses in Lesotho. **Methods:** Two surveys were undertaken; one prior to implementation of the first modular training programme and one approximately 9 months after its completion. For each survey, around 300 randomly selected horses were clinically examined, their tack was assessed and their owners interviewed to assess knowledge and practice of equine husbandry. Differences between the findings of the 2 surveys were assessed for significance using Chi-squared and t tests. **Results:** Most horses (ca. 80% in both surveys) provided ridden transport and were used approximately 2 h each working day. An increase in the frequency of forefoot shoeing was seen (14% in Survey 1 vs. 22% in Survey 2, P = 0.02). Owners appreciated the enhanced skills of the charity’s trained farriers but affordability of shoeing remains an issue for most owners (ca. 60% in both surveys). No significant improvement in the condition or fit of tack was noted. Tack-associated injuries (58% in Survey 1 vs. 75% in Survey 2) and pain on spinal palpation (53% in Survey 1 vs. 67% in Survey 2) were common. Horses’ mean body condition score remained suboptimal (2.5 and 2.2, 1–5 scale) and owners recognised that their animal’s diet was unbalanced (ca. 60% in both surveys). In both surveys 21% of horses had low red blood cell counts. Infestation with Strongyle endoparasites was endemic (ca. 90% in both surveys) and ticks were found on most horses (ca. 60% in both surveys). **Conclusions:** Some short-term positive impact has been achieved but key equine health and welfare issues remained to be addressed. **Practical significance:** Results of this work could be used to identify priority areas for future training activities and additional community-based interventions.

Clinical effects of treatment of suspected synovitis in the equine distal limb with nonsteroidal anti-inflammatoory drugs, intrasynovial corticosteroids, or a combination of systemic treatment and intra-synovial medication: 104 cases (2004–2007)

**Brommer, H. and Schipper, P.**

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**Aim:** To compare the clinical effects of application of either nonsteroidal anti-inflammatory drugs (etodolac and meloxicam) systemically (Group 1), corticosteroids (methylprednisolone acetate, triamcinolone acetonide or dexamethasone) intrasynovially (Group 2), or both (Group 3), in horses that were treated for synovitis of the distal limb. **Methods:** Evaluation of data files of lame horses examined at the Department of Equine Sciences of Utrecht University, The Netherlands and that were subsequently treated for synovitis of the distal limb. **Results:** One-hundred-and-four cases did meet the requirements of the inclusion criteria with 40, 30 and 34 horses in Groups 1, 2 and 3, respectively. Positive outcome results were as follows:

<table>
<thead>
<tr>
<th>Synovial cavity</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCPJ (n = 53)</td>
<td>30%</td>
<td>29%</td>
<td>69%</td>
<td>0.045</td>
</tr>
<tr>
<td>DFTS (n = 20)</td>
<td>0%</td>
<td>45%</td>
<td>83%</td>
<td>0.065</td>
</tr>
<tr>
<td>DIPJ (n = 31)</td>
<td>25%</td>
<td>8%</td>
<td>33%</td>
<td>0.313</td>
</tr>
</tbody>
</table>

**Conclusions:** The most common positive outcome was defined when the horse was sound at least after 6 months and returned to previous level of performance. Statistical analysis was performed using a Chi-square test. **Results:** One-hundred-and-four cases did meet the requirements of the inclusion criteria with 40, 30 and 34 horses in Groups 1, 2 and 3, respectively. Positive outcome results were as follows:
There was no influence of the age of the horses, duration of lameness, severity of lameness, or the results of diagnostic imaging (radiography, ultrasonography). **Conclusions:** For suspected synovitis of the MCPJ or the DFTS, but not of the DIPJ, a combination of systemic and local intrasynovial treatment has a better outcome than a separate treatment of both modalities. **Practical significance:** Suspected synovitis of the MCPJ or the DFTS carry a fair prognosis after systemic treatment of NSAIDs combined with corticosteroids intrasynovially without further diagnostics. In cases of suspected synovitis of the DIPJ, advanced diagnostics prior to medial therapy are advocated.

**Radiographic anatomy of the thoracic facet joints in the horse**

_Akers, C., Belcher, N. and Weller, R._

*The Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Herts. AL9 7TA, UK. cakers@rcv.ac.uk*

**Aims:** Osteoarthritis of the thoracolumbar facet joints has been associated with back pain in the horse and presents a diagnostic challenge largely due to the difficulties in imaging this region radiographically. The aim of this study was to demonstrate the radiographic anatomy of thoracolumbar facet joints and to optimise radiographic procedure. **Methods:** Four cadaveric backs were radiographed using a series of projections and settings. The cadavers were subsequently dissected and boiled out. The skeletons were then re-radiographed after important anatomical features were identified with radio-opaque markers. Computed tomography was performed on one back to create a 3D model of the skeleton which was then registered onto the corresponding radiographs. The best views identified from the cadaver study were then tested in 2 live horses. **Results:** It was found that a 20˚caudo20˚ventral-craniodorsal oblique projection was best for visualising the facet joint on the skeleton especially more caudally, but was distorted on the live horse, due to the distance of the cassette from the spine. A latero20˚ventral-laterodorsal oblique (L20˚V-LDO) projection was clearest on a live horse. It was not possible to avoid all superimposition of other structures but this view best avoids the edges of the ribs and mammillary processes. It was possible to match 2D radiographic features with the 3D computer model, which facilitated differentiation of normal anatomy from pathological changes. **Conclusion and practical significance:** L20˚V-LDO projection of both sides and a single lateral projection provide the clearest views. The 3D model helps to understand which normal radiographic anatomy lies in the way of the facet joint and to relate this to opacities on the radiographs.

**The effects of nerve blocks and circular trotting on the kinematics of hindlimb lame horses**

_Walker, A.M., Wilson, A.M. and †Pfau, T._

*Structure and Motion Lab, Department of Veterinary Basic Sciences; and †Structure and Motion Lab, Department of Veterinary Clinical Sciences, The Royal Veterinary College, Hatfield, Herts. AL9 7TA, UK. amwalker@rvc.ac.uk*

**Aims:** To quantify the effect of nerve blocks on dorsoventral pelvic displacement in hindlimb lame horses during straight and circular trotting. **Methods:** Inertial sensors were attached to the sacrum and both tuber coxae of 3 hindlimb lame horses. Horses were trotted in a straight line and on left and right lunge. Vertical displacement amplitudes during left and right stance were determined before and after nerve blocks and symmetry ratios compared. **Results:** All 3 horses were 4/10 left lame on initial assessment. Compression and push off were lower in the lame limb. Prior to nerve block, 2 horses exhibited a compensatory increase in loading and push off from the nonlame limb. All horses showed increased lameness score during straight and left rein trotting compared to the right rein. After nerve block (tibio-perineal, stifle and deep branch of the lateral plantar nerve respectively), symmetry ratios increased by >20% associated with a change in visual locomotion score in all horses from 4/10 to 1/10 on the left rein. **Conclusions and practical significance:** Inertial sensors reliably measure the pelvic displacement in hindlimb lame horses and provide a means of objectively quantifying the asymmetry of lameness, circle motion and the outcome of nerve blocks. The system has utility as a clinical, teaching and lameness assessment tool and to monitor progression/rehabilitation.

**Acknowledgements:** Clinicians from the RVC Equine Referral Hospital and the horse owners.

**Differences in frontal plane joint angles between walk and trot**

_Unt, V.E., Pfau, T. and Weller, T._

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**Aims:** The ground reaction force acting on the limb during locomotion increases from walk to trot. This study compares frontal plane joint angles in the carpal, metacarpophalangeal (MCP), tarsal and metatarsophalangeal (MTP) joints at walk and trot. **Methods:** Kinematic data were acquired for 6 ponies of the fore- and hindlimbs using 3D optical motion analysis (Qualisys). Frontal plane joint angles were calculated for midstance at walk and trot the carpal, MCP, tarsal and MTP joints using MATLAB. Statistical analysis were performed using the independent sample t test (P<0.05). **Results:** The MCP joint angle showed a significant difference (P = 0.001) between walk and trot, changing from a valgus angulation to a varus angulation, the angle was 178.1 ± 7.45° (mean ± s.d.) at walk, changing to 182.4 ± 10.8° when trotting. In the tarsus and MTP joints a significant difference (P<0.0001) towards an increasing valgus deformity was observed: 172.9 ± 2.7° to 169.4 ± 3.17° in the tarsus and 176.4 ± 5.1° to 169.4 ± 6.3° in the MTP. There was no significant difference between walk and trot in the carpus (P = 0.782). **Conclusion and practical significance:** Joint conformation in the frontal plane changes with gait and should be considered when using conformation as an indicator of orthopaedic health.

**Acknowledgements:** This work is funded by the Horserace Betting Levy Board.

**The effect of lateral heel studs on the kinematics of the equine digit while cantering on grass**

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**Aims:** This study aimed to quantify the effect of studs on hoof-ground interaction during stance in horses cantering on a

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Validating a clinical recording system for diagnosing equine laminitis

Wylie, C.E., Collins, S.N., Verheyen, K.L.P. and Newton, J.R.

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Aims: To determine the validity of a clinical recording system for diagnosing equine laminitis. Methods: A ‘laminitis reporting form’ (LRF) consisting of specific clinical signs was developed based on a literature review of clinical signs for laminitis and its differential diagnoses, and expert opinion. Practitioners at 5 veterinary institutions (2 referral centres, 2 first-opinion equine hospitals and a first-opinion mixed practice) completed the LRF for cases of lameness of any origin seen between February and April 2009. In addition, practitioners detailed the lameness diagnosis and the diagnostic modalities used. An independent reviewer collated all LRF data prior to statistical analysis. For each clinical sign, sensitivity, specificity, positive and negative predictive values were calculated using 2-by-2 tables. The difference in the prevalence of each clinical sign between laminitis cases (cases) and other lamenesses (controls) was also determined. Results: One-hundred-and-twenty-eight completed LRFs were received. The sensitivity of short stilted gait at trot, difficulty turning, lame at walk and lame at trot were >90%. Prolapsed sole and coronary band depression had a specificity and positive predictive value of 100%. The clinical signs with the greatest positive difference in prevalence between cases and controls were short stilted gait at walk (71.5%), difficulty turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest negative difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest positive difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest negative difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest positive difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest negative difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%).

Conclusions: The LRF was validated using 2-by-2 tables. For each clinical sign, sensitivity, specificity, positive and negative predictive values were calculated. Further analysis will identify criteria to help veterinarians diagnose laminitis in the field. Acknowledgements: This project is funded by World Horse Welfare.

In vitro effect of antibiotic concentration and type on cell proliferation and viability of equine bone marrow derived mesenchymal stromal cells

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Aims: To assess the in vitro effects of varying concentrations of gentamicin, amikacin, penicillin, enrofloxacin and cefetiofur sodium on equine bone marrow derived mesenchymal stromal cell proliferation and viability. Methods: Equine mesenchymal stromal cells were aspirated from the sternum of 2 healthy donors. Equine bone marrow derived mesenchymal stromal cells were expanded in vitro and then used for the study. A group of 96 lame horses were studied. In addition, practitioners detailed the lameness diagnosis and the diagnostic modalities used. An independent reviewer collated all LRF data prior to statistical analysis. For each clinical sign, sensitivity, specificity, positive and negative predictive values were calculated using 2-by-2 tables. The difference in the prevalence of each clinical sign between laminitis cases (cases) and other lamenesses (controls) was also determined. Results: One-hundred-and-twenty-eight completed LRFs were received. The sensitivity of short stilted gait at trot, difficulty turning, lame at walk and lame at trot were >90%. Prolapsed sole and coronary band depression had a specificity and positive predictive value of 100%. The clinical signs with the greatest positive difference in prevalence between cases and controls were short stilted gait at walk (71.5%), difficulty turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest negative difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest positive difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest negative difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest positive difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%). The clinical signs with the greatest negative difference in prevalence between cases and controls were square stance (-10%), front feet turning (65%), and short stilted gait at trot (62.7%).

Conclusions: The LRF was validated using 2-by-2 tables. For each clinical sign, sensitivity, specificity, positive and negative predictive values were calculated. Further analysis will identify criteria to help veterinarians diagnose laminitis in the field. Acknowledgements: This project is funded by World Horse Welfare.

Field trial validation of the efficacy and acceptability of firocoxib, a highly selective COX-2 inhibitor, in a group of 96 lame horses

Pollmeier, M.G., Koene, M., Goupil, X., Kampmann, C., Hanso, P.M., Romano, D. and Back, W.

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Aims: To assess the in vitro effects of varying concentrations of gentamicin, amikacin, penicillin, enrofloxacin and cefetiofur sodium on equine bone marrow derived mesenchymal stromal cell proliferation and viability. Methods: Equine mesenchymal stromal cells were aspirated from the sternum of 2 healthy donors immediately after euthanasia for orthopaedic reasons. Cells were cultured to passage 2 after which they were transferred to media containing gentamicin, amikacin, penicillin, cefetiofur sodium or enrofloxacin, each at a concentration of 50 µg/ml, 100 µg/ml, 200 µg/ml and 500 µg/ml. An Alamar Blue fluorescence assay was used to assess cell proliferation and viability at 3, 24 and 48 h post antibiotic treatment, compared with antibiotic-free controls. Statistical analysis in the form of mixed effects linear regression was carried out using S-Plus software. Results: Enrofloxacin produced a significant concentration dependent reduction in cell proliferation and viability at concentrations of 200 µg/ml and greater (P = 0.007). Cefetiofur sodium produced a significant concentration dependant increase in cell viability and proliferation at concentrations of 100 µg/ml and greater (P = 0.008). Amikacin (P = 0.212) and penicillin (P = 0.139) had no significant effect at any time or concentration. Gentamicin produced a significant increase in cell viability and proliferation at 500 µg/ml (P = 0.003) but not at lower concentrations. Conclusions: Enrofloxacin has significant in vitro cytotoxic effects on equine bone marrow derived mesenchymal stromal cells. Amikacin and penicillin at concentrations up to 500 µg/ml did not alter cell viability compared with control cells. Cefetiofur sodium and gentamicin increased cell viability and proliferation at higher concentrations.

Practical significance: Intravenous perfusion with enrofloxacin at any concentration is not recommended. The use of gentamicin, amikacin, penicillin and cefetiofur sodium by this route appears safe at concentrations up to 500 µg/ml. The in vitro use of cefetiofur sodium and gentamicin may be stimulatory at certain concentrations and warrants further investigation.

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Aims: To assess the in vitro effects of varying concentrations of gentamicin, amikacin, penicillin, enrofloxacin and cefetiofur sodium on equine bone marrow derived mesenchymal stromal cell proliferation and viability. Methods: Equine mesenchymal stromal cells were aspirated from the sternum of 2 healthy donors immediately after euthanasia for orthopaedic reasons. Cells were cultured to passage 2 after which they were transferred to media containing gentamicin, amikacin, penicillin, cefetiofur sodium or enrofloxacin, each at a concentration of 50 µg/ml, 100 µg/ml, 200 µg/ml and 500 µg/ml. An Alamar Blue fluorescence assay was used to assess cell proliferation and viability at 3, 24 and 48 h post antibiotic treatment, compared with antibiotic-free controls. Statistical analysis in the form of mixed effects linear regression was carried out using S-Plus software. Results: Enrofloxacin produced a significant concentration dependent reduction in cell proliferation and viability at concentrations of 200 µg/ml and greater (P = 0.007). Cefetiofur sodium produced a significant concentration dependant increase in cell viability and proliferation at concentrations of 100 µg/ml and greater (P = 0.008). Amikacin (P = 0.212) and penicillin (P = 0.139) had no significant effect at any time or concentration. Gentamicin produced a significant increase in cell viability and proliferation at 500 µg/ml (P = 0.003) but not at lower concentrations. Conclusions: Enrofloxacin has significant in vitro cytotoxic effects on equine bone marrow derived mesenchymal stromal cells. Amikacin and penicillin at concentrations up to 500 µg/ml did not alter cell viability compared with control cells. Cefetiofur sodium and gentamicin increased cell viability and proliferation at higher concentrations.

Practical significance: Intravenous perfusion with enrofloxacin at any concentration is not recommended. The use of gentamicin, amikacin, penicillin and cefetiofur sodium by this route appears safe at concentrations up to 500 µg/ml. The in vitro use of cefetiofur sodium and gentamicin may be stimulatory at certain concentrations and warrants further investigation.
Noninvasive determination of atrial fibrillation cycle length by means of tissue Doppler imaging

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Aims: To investigate the applicability and to report values of tissue Doppler imaging (TDI) of the left atrial wall and interatrial septum for determination of atrial fibrillation cycle length (AFCL) in horses with naturally occurring atrial fibrillation (AF). AFCL is the time (ms) between 2 atrial depolarisations during AF. It reflects atrial effective refractory period which is related to AF susceptibility.

Methods: Ten episodes of naturally-occurring AF were examined (9 horses of which one with AF recurrence after 1 year was examined twice). TDI velocity tracings or M-mode images were obtained from the interatrial septum (tilted 4-chamber view) and the left atrial wall (left caudal long-axis view). A displayed depth between 22 and 30 cm (GE Vivid7pro, 35 probe). TDI showed oscillations of the atrial myocardium during diastole, resulting in a velocity shift. The time between these oscillations was measured as the AFCLTDI. Within 24 h, right AFCL was measured invasively from an intra-atrial pacing electrode.

Results: Clear myocardial oscillations with a velocity around ± 0.5 cm/s could be identified allowing proper AFCLTDI measurement in all horses. Mean left atrial (left view) AFCLTDI was 29 ± 25 ms and 150 ± 12 ms respectively. A significant correlation was found between both TDI-obtained values (r = 0.87; P = 0.001) but not between the TDI and the invasively measured (right atrial) AFCL.

Conclusions and practical significance: TDI might be a useful noninvasive means to measure AFCL in AF horses. The difference between AFCL and AFCLTDI might be related to the measuring technique and to temporal and spatial (right vs. left) dispersion in AFCL. Simultaneous TDI and invasive AFCL measurements from the same myocardial site need to be studied to elucidate the difference.

A retrospective study of Doppler echocardiographic findings in horses referred in a Belgian equine clinic

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Aims: The aim of this retrospective study was to describe the echocardiographic abnormalities most frequently diagnosed in horses admitted at the teaching Equine Clinic of Liege between 1994 and 2009 and submitted to echocardiography because of a suspicion of a cardiac problem.

Methods: Horse’s breed, sex, age and bodyweight (BW), reason for consultation, and final echocardiographic diagnosis were recorded. A total of 365 cases (133 mares, 173 geldings and 59 stallions; mean BW: 531 ± 106 kg; mean age: 9.6 ± 6.6 years) from the database were analysed.

Results: The most frequent reasons for consultation were detection of a cardiac murmur or exercise intolerance. Mitral regurgitation (MR) was the most frequently detected...
echocardiographic abnormality (210 cases). Aortic and tricuspid regurgitation (AR and PR, respectively) were also frequent (125 and 115 cases, respectively). Pulmonary regurgitation (PR) and ventricular septal defect were detected in 64 and 10 cases, respectively. The mean BW was significantly higher in cases with MR than in cases with AR, and the mean age was significantly higher in cases with AR than in cases with MR and TR. The regurgitation was classified on Doppler examination as severe in 18, 15, 12 and 6% of the MR, AR, TR and PR cases, respectively. Amongst the cases with a severe MR, AR, TR and PR, 27, 5, 43 and 75%, respectively, showed clinical signs of congestive heart failure (CHF). The intensity of the murmur was significantly different in horses having different severity of regurgitation on Doppler examination. **Conclusions:** This study is in agreement with literature. It suggests that heavier and older horses are more at risk of developing MR and AR, respectively, and that horses with AR are less at risk of developing CHF than horses with other valve regurgitation. Moreover, MR was the most common abnormality evidenced on echocardiography in the analysed population.

**Treatment of lameness by surgical resection of the palmar/plantar annular ligament (PAL)**

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**Aims:** To document 2 methods for surgical resection of the PAL as treatment for lameness associated with persistent focal pain due to chronic lesions. **Methods:** Data were reviewed from 6 horses presented to 2 referral hospitals. Cases were included if they had lameness emanating from the palmar or plantar fetlock region that was attributable to focal damage (including dystrophic mineralisation) within the PAL and were then subsequently treated surgically. Surgical intervention included tenoscopic evaluation and was performed under general anaesthesia in all cases: 3 horses then underwent en bloc resection of the entire annular ligament; 3 horses underwent a more localised resection of the injured tissue and closely associated ligament only. Histological examination of resected tissue was performed in 3 cases. **Results:** Duration of lameness before referral ranged from 5 weeks to 5 months. Degree of lameness ranged from grades 3 to 5 out of 10. All horses had lameness localised to the palmar/plantar fetlock though there was variation in their responses to regional and intra-synovial anaesthesia. Tenoscopy documented fibrillation of the opposing superficial digital flexor tendon in 2 horses, but this was not associated with a reduced outcome. All horses recovered and were discharged from the hospitals without complications. Follow-up data available currently indicates that both surgical techniques resulted in highly satisfactory results. Importantly, post operative ultrasound examinations suggested regeneration of the resected ligaments following both techniques. Three horses are subsequently treated surgically. Surgical intervention included tenoscopic evaluation and was performed under general anaesthesia. Three horses are described in detail. The validation of HRV as an objective measure of laminitic pain was possible in the horses in this study. **Clinical relevance:** Previous findings from our department indicate that there is a neuropathic pain element in laminitis in horses (Jones et al. 2007), which commonly shows a lack of correlation with other clinical and/or diagnostic findings such as radiographic changes. HRV can be useful in association with other parameters to give a more detailed picture of the horse’s welfare. This will allow earlier and better interpretation of the effect of therapeutic interventions. **Acknowledgements:** This project is generously funded by the Horse Trust. Some associated quantitative assessment measurements have been identified through funding opportunities provided previously by The International League for the Protection of Horses.

**References**


Horses had a median age of 12 years, included 69% geldings and charts (1999–2006) were reviewed and analysed. Associations between certain malocclusions and the age group present in a general equine population, and investigate potential associations between certain malocclusions and the age group and gender of affected horses. To examine the prevalence and types of malocclusions a standardised scoring system was used to test the null hypothesis that BFs and BFS change would be zero. The horses were grouped according to 3 different exercise regimes and 3 feeding groups. The differences in fat change between the exercise and feeding groups were evaluated with ANOVA. There was a significant reduction in both BF% (P<0.01, 95% CI: 1.65–3.15 mean difference = 2.40) and BFS (P = 0.02, 95% CI: 0.01–0.14, mean difference = 0.08). The horses at a lower intensity of exercise (Groups 1 and 2) had the greatest loss of body fat (mean BF% loss 2.84% and 2.51%, respectively) but the difference between the 3 exercise groups was not statistically significant (F test, P = 0.83). Conclusion and practical significance: Simple management changes such as limiting the horses’ grazing and frequent low intensity exercise can result in significant reductions in body fat. This reduction can be detected with both monitoring methods.

**Associations of certain dental malocclusions with age group and gender of horses**

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Aims: To examine the prevalence and types of malocclusions present in a general equine population, and investigate potential associations between certain malocclusions and the age group and gender of affected horses. Methods: Data from 100 dental charts (1999–2006) were reviewed and analysed. Results: Horses had a median age of 12 years, included 69% geldings and 31% mares and 52% had cheek teeth (CT) and/or incisor malocclusions. Incisor malocclusions affected 35%, including overbite (8% prevalence), ventral curvature of occlusal surface (21%), and irregular occlusal surface (6%). Cheek teeth (CT) malocclusions affected 42% and included focal overgrowths (19%), sloping overgrowths (15%), tail CT (16%) and jaw overbite (8%). Using Chi-square tests, statistical associations (P<0.05) were demonstrated between: the 6–10 year age group and overbite and focal CT overgrowths; 11–15 year age group and any incisor malocclusion; 16–20 year age group and irregular incisor occlusal surfaces, any incisor malocclusion and focal CT overgrowths; 21–25 year age group and any incisor malocclusion and jaw overbite; 26–30 year age group and ventral incisor curvature, sloping CT overgrowths and tail CT. Dependence were also demonstrated between gender and any malocclusions, any incisor malocclusions and ventral incisor curvature. Conclusions and practical significance: The prevalence and type of incisor and CT malocclusions recorded differed from those of referral populations. An association was found between certain types of malocclusion and age group which highlights the need for targeted dental treatment in different age groups. The association of gender with certain malocclusions may have been affected by the predominantly neutered male population examined. Acknowledgements: Thanks to D. Shaw, T. Johnson and P. Ramzan for guidance with this paper.

**Bilateral hip dysplasia in foals: another disease necessitating further genetic workup of the Friesian horse population?**


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Aims: In dogs, hip dysplasia is commonly diagnosed in pelvic limb discomfort and disability. Joint laxity, articular depth and signs of osteoarthritis are confirmed on ventrodorsal radiographs of the pelvis. To date, this disease is unknown in horses, although practitioners have reported this anecdotally in Friesian horses. Methods: Three Friesian foals of 8 months old were admitted to Utrecht University, Department of Equine Sciences for Computer Tomography (CT) evaluation of their hip joints. One foal showed progressing kyphosis, a typical presentation of affected horses. To a more optimal quantification and comparison

**The effect of controlled feeding and exercise on the body fat % in Warmblood horses, assessed by a standardised scoring system and ultrasound measurement of rump fat**

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Aims: 1) To determine whether there is a change in body fat level in stabled horses after 6 weeks of controlled exercise and feeding, preceded with pasture rest, that is detectable using both body fat % (BF%) and body fat scoring (BFS) techniques. 2) To compare body fat changes between different exercise and feed groups. Methods: Thirty-three healthy Warmblood horses from one establishment, aged 7–19 years, 12 mares and 21 geldings, were evaluated twice for their level of body fat: at return from 8 weeks of pasture rest and again after 6 weeks of controlled exercise and feeding. BF% was calculated from rump fat thickness measured with ultrasound. The BFS was calculated as the mean of the scores given to the neck, trunk and rump. Each site was graded on a 5-point scale (with half point allowed): I = normal, II = subcutaneous fat deposit, III = raised subcutaneous fat deposit, IV = fat deposit over bone. Results: There was a significant reduction in both BF% (P<0.001, 95% CI: 1.65–3.15 mean difference = 2.40) and BFS (P = 0.02, 95% CI: 0.01–0.14, mean difference = 0.08). The horses at a lower intensity of exercise (Groups 1 and 2) had the greatest loss of body fat (mean BF% loss 2.84% and 2.51%, respectively) but the difference between the 3 exercise groups was not statistically significant (F test, P = 0.83). Conclusion and practical significance: Simple management changes such as limiting the horses’ grazing and frequent low intensity exercise can result in significant reductions in body fat. This reduction can be detected with both monitoring methods.
Conclusions:
Osteochondrosis in the hip joint with consequent malformation and severe osteoarthritis, diagnosed by CT and confirmed by pathological examination, demonstrates hip dysplasia as a differential diagnosis of bilateral foal hindlimb shortened gait. Practical significance: When encountering a typical weight shifting stance in the hindlimbs together with kyphosis and a shortened hindlimb gait, bilateral hip joint pain should be on the differential diagnosis list, as caused by dysplasia, arthrosis and/or osteochondrosis. Being reported in a Friesian, a genetic background can be suspected, necessitating quantitative evaluation of this syndrome in a larger group of foals to come to a classification system for hip dysplasia, similar as in dogs and to a better understanding of its relationship to other, more commonly diagnosed diseases of the musculoskeletal system, such as arthrosis and osteochondrosis.

Characterising the angular-time profile of the metatarsal in walk and trot and relating to swing and stance phase

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Aims: 1) To validate a method of measuring the metatarsal angle throughout the stride cycle during walk and trot using inertial motion sensors (IMS) and 2) identify the stance and swing phases within the metatarsal angle – time relationship by direct comparison to a 3D motion capture system. Methods: Seven horses were equipped with IMS placed within boots fitted to the left and right metatarsals. Two reflective markers were placed on the proximal and distal left metatarsal for 3D motion capture. A third marker was placed on the lateral left hind hoof wall to enable the start and end of stance phases to be identified on the angle-time relationship. Trials were conducted on a treadmill in walk (1.4 m/s) and trot (3.1 m/s). Data were collected throughout simultaneous 10 s periods using each system. Results: The equine sphenopalatine sinus: assessment of normal anatomy by different diagnostic techniques and eight cases of primary sphenopalatine sinus disease

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Aims: To assess the normal anatomy of the sphenopalatine sinus (SPS) by different diagnostic techniques and to describe the clinical features, diagnostic methods, treatments used and outcomes in 8 horses with primary SPS disease. Methods: Computed tomographic (CT), sinonscopic, plain and contrast radiographic images of the SPS were obtained from 10 equine cadaveric heads using a standardised protocol. The cadaveric

The use of scintigraphy as a quantitative assessment of horses with pelvic fractures

Crosby, S.A., †Crawford, A., †Bolt, D., †Fiske-Jackson, A., †Eliashar, E., O’Donnell, M., †van Pelt, R., †du Preez, P. and †Smith, R.K.

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Aims: A retrospective study of horses with scintigraphically diagnosed pelvic fractures and the use of a quantitative assessment technique to determine the pattern of healing for ileal stress fractures. Methods: The records of all horses diagnosed using scintigraphy with a pelvic fracture between 2003 and 2009 were categorised into anatomical location to determine incidence. Ilial wing fractures which underwent more than one scintigraphic examination were assessed quantitatively. Standard images from bone-phase scans of the ilial wing fractures were quantitatively analysed using regions of interest (ROI) around the area of increased radiopharmaceutical uptake (IRU) at the fracture site and compared to ROIs around L5. The interval to return to racing for ileal fractures was determined via raceroform data from the Racing Post® website. Results: Seventy-three horses were diagnosed with pelvic fractures using scintigraphy over the 6 year period. The mean age was 4.15 years (range 2–15). There were 36 females, 33 geldings and 4 entire males. Ilial wing fractures were the most common pelvic fracture (76.7%), followed by ischial fractures (12.3%). Of the ileal fractures 48/56 (85.7%) were unilateral and 8/56 (14.2%) were bilateral. There was no significant difference between left and right sided fractures (left; 56%, right; 44%, P = 0.56), and the interval between diagnosis and return to racing for horses with unilateral vs. bilateral fractures was not significantly different (P = 0.36) (unilateral, mean 260.8 days; bilateral, mean 259.8 days). Twenty horses with ileal fractures provided data for the quantitative assessment with time. This showed a rise in IRU at the fracture site over the first 6 weeks post injury. The mean of the fracture ROIs fell to 60% of their initial IRU by 120 days. Conclusions and practical significance: This information can be used to aid the management of pelvic ileal wing fractures and provide information as to expected return to racing.

The use of scintigraphy as a quantitative assessment of horses with pelvic fractures

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Validation of the deuterium oxide (D$_2$O) dilution method for the measurement of body fat content in living ponies

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Aims: To develop an accurate method for the determination of actual body fat content (total body lipid [TBL] or white adipose tissue [WAT]), in living equidae. Methods: Seven mature (13 ± 2 years, 212 ± 14 kg), healthy, Welsh section A pony mares, destined for euthanasia (for nonresearch purposes) were used. Ponies were weighed (± 1 kg) and body condition scored (BCS, 1–9). Deuterium is a stable isotope tracer used for measurement of total body water from which total body fat mass may be inferred. Blood samples (20 ml) were collected by jugular venepuncture before and 4 h after D$_2$O (99.8 atom percent excess) administration through a contralateral venous catheter. D$_2$O infusions were: 0.11 g/kg bwt for obese (BCS 7–9); 0.12 g/kg bwt for moderate (BCS 4–6) and 0.13 g/kg bwt for thin (BCS 1–3) ponies. Plasma was immediately harvested and stored at -80°C in air-tight tubes pending analysis by gas isotope ratio mass spectrometry, following zinc reduction of the stable hydrogen isotopes. After euthanasia, total WAT mass (excluding intramuscular WAT) was recorded (± 0.1 kg) before proximate chemical analyses of all body tissues. Results: Coefficients of determination ($r^2$) following independent regression of D$_2$O-derived body fat estimates on TBL and WAT contents were 0.99 and 0.98, respectively. Bland-Altman plots confirmed that the D$_2$O-dilution technique provided a useful alternative to either dissection or chemical analysis in the measurement of body fat content. D$_2$O-dilution underestimated TBL by 2.6 ± 1.2% and WAT by 0.7 ± 1.8%. Calibration factors were slightly increased with increased BCS. Importantly, body fat content increased exponentially and not linearly with increased BCS. Conclusions and practical significance: This study provides the first validation of a minimally-invasive protocol for the accurate, objective and importantly, nondestructive measurement of body fat content in living equidae. Acknowledgements: The study was supported by World Horse Welfare and BBSRC.

Scintigraphic anatomy of the thoracolumbar facet joints in the horse

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Aims: Back problems are common and pathology of the thoracic and lumbar facet joints has been recognised as one of the causes. Diagnosis of back disorders is challenging and scintigraphy is commonly used in an attempt to localise the pathology. This study demonstrates the scintigraphic anatomy of the equine facet joints from T17–L6 as these joints are most commonly described as having facet joint pathology. Methods: The study was conducted using 2 equine backs acquired from a local abattoir. The soft tissues were dissected from the vertebrae and plastic tubing used to outline the facet joints, mamillary processes, dorsal spinous processes, the transverse processes and the caudal and cranial surfaces of the vertebral bodies. A solution containing 10 MBq/ml 99m-Tc coloured with methylene blue was injected into the tubes and dorsal, left lateral and 30° dorsolateral oblique static images were acquired with a gamma camera using a set count of 250,000. Results: In the dorsal scans, the dorsal spinous processes and mamillary processes were superimposed on the facet joints. In the left lateral scans the left mamillary processes were superimposed on the facet joints as was the cranial edge of the transverse process of L1. In the oblique views the left mamillary processes were superimposed on the left facet joints. Conclusion and practical significance: A number of structures may be superimposed on the facet joints in the standard views used in scintigraphy of the equine spine. It is therefore important that dorsal, right oblique, left oblique, left lateral and right lateral views are acquired to facilitate accurate identification of the anatomical location of increased radiopharmaceutical uptake.