EQUINE VETERINARY EDUCATION/AMERICAN EDITION

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JULY 2020

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American Edition | July 2020

BEVA

The official journal of the American Association of Equine Practitioners, produced in partnership with BEVA.

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AMERICAN EDITION

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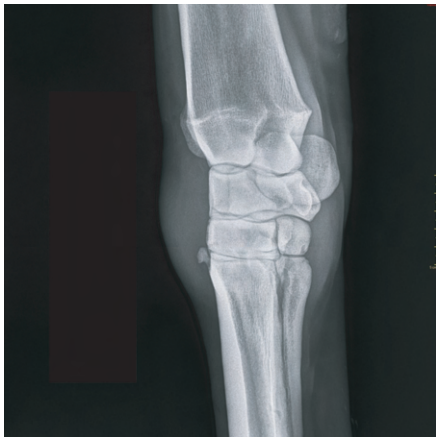

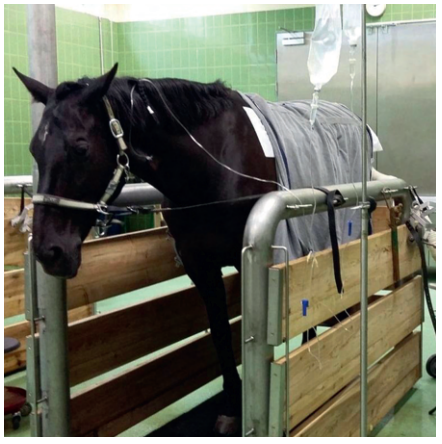

AAEP NEWS In this issue

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EQUINE VETERINARY EDUCATION
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Equine Veterinary Education is a refereed educational journal designed to keep the practicing veterinarian up to date with developments in equine medicine and surgery. Submitted case reports are accompanied by invited reviews of the subject (satellite articles) and clinical quizzes. Tutorial articles, both invited and submitted, provide in-depth coverage of issues in equine practice.

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5 strategies to help your practice prosper during the current pandemic

The coronavirus pandemic has presented plenty of practice challenges but also opportunities to position for long-term growth, according to the co-presenters of the AAEP's May 27 webinar "5 Smart Strategies for Practice Success During the Age of COVID-19."

Dr. Amy Grice, owner of Veterinary Business Consulting in Virginia City, Mont., and Dr. Kelly Zeytoonian, owner of Starwood Equine Veterinary Services and Starwood Veterinary Consulting Inc. in Redwood City, Calif., assessed the impact of COVID-19 on the general economy and veterinary practice before zeroing in on the following 5 strategies to help equine practices prosper during this unusual time.

1. Address income disparity

Lower-income clients represent the second-highest horse-per-owner level, and these clients will continue to seek veterinary care for essential work. Enhance service to these clients by offering vaccine clinics or group rates through which you waive the farm call or charge a reduced price for the efficiency of having a higher volume of clients in one location. You can also implement wellness programs with rolling payments to help clients budget more effectively, and offer technician visits at a lower cost.

In addition, hop on board the "giving economy" by creating how-to articles or videos that empower clients to perform simple tasks and educate on when they need to call their vet; and enroll in AAEP's Vet Direct Safety Net program to provide up to $600 for emergency stabilization, humane euthanasia or disposal for horses owned by clients experiencing financial difficulty.

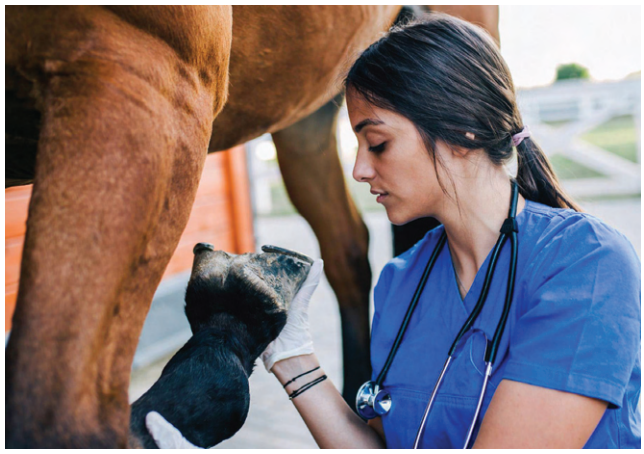
2. Launch telehealth services

Many veterinarians already practice telehealth simply by answering case-specific questions from clients via text, email or phone; however, if you are not charging for such service, you should be compensated for the answers and peace of mind you're providing.

Start by documenting and billing for these texts, calls and emails. It's important not to surprise clients so consider documenting it at a 100% discount on the invoice but state that it will be charged for in the future. Further reduce the burden of farm calls by expanding your telehealth services using FaceTime, Zoom or Google Meet—charging for these face-to-face meetings the amount you would charge for an in-person consult.

3. Maximize employee utilization

Employees account for 35-45% of practice expenses so use your team wisely and communicate with them openly and honestly. Rewrite job descriptions if duties and tasks have changed during the current pandemic. This will help reduce anxiety about expectations and offset reduced productivity that often accompanies times of stress.



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Consider offering extended care services performed by vet techs to maximize employee utilization.

When examining ways to reduce costs, consider increasing or modifying employee duties to delay reductions in hours or salaries. Measures could include offering extended care services such as bandage changes and medications administered by vet techs; and replacing outside service providers with staff for tasks such as vehicle washing, janitorial services, and social media and website management.

4. Optimize inventory management

Inventory is the second-highest cost as a percentage of expenses, and every dollar spent on inventory results in an additional $0.23 to $0.35 in ordering and holding costs. As such, only keep what you will use or sell before payment is due and create an order list for how much supply you should keep, adjusting as necessary.

Strategies to manage your inventory expense include requiring payment at time of delivery, relying more heavily on online pharmacies to reduce ordering and holding costs, billing for everything instead of providing freebies to owners during a farm visit, creating a buying group with other practices and negotiating extended payment terms with distributors.

5. Understand financial statements

Review your Profit and Loss statement regularly. Compare time periods to monitor the effects of implemented strategies and respond to trends in your business. Investigate any major changes.

The 57-minute webinar and presenter slide decks are accessible through the Business & Economics link at aaep.org/resources/covid-19-resources-veterinarians.

The increasing value of veterinary technicians

By Deborah B. Reeder, LVT, RVT, VTS-EVN

Editor's note: Following is an excerpt from the article "Ethical and professional utilization of the credentialed veterinary technician and assistant." Read the full article at https://tinyurl.com/aaepepucvt

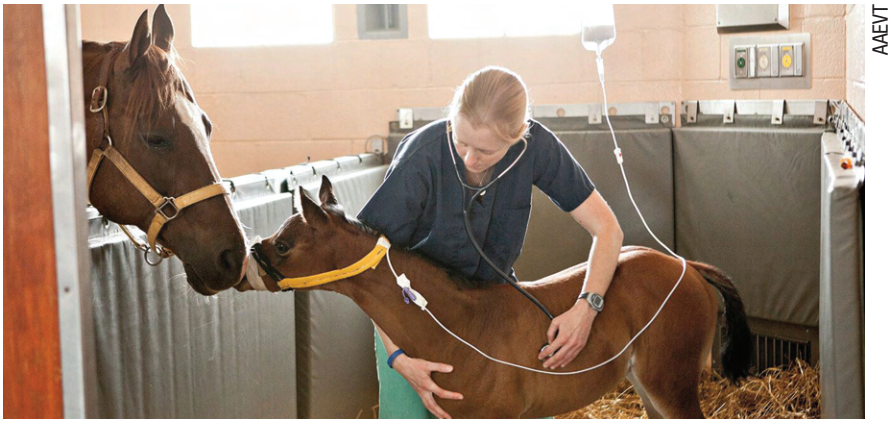
As technology becomes more important in the medical services offered in both small and large animal practice, the role of the veterinary technician will become even more valuable. The veterinarian will need to rely increasingly on their support staff to understand, implement and use new equipment, new software and new diagnostic tools and technology. Digital radiology, ultrasound and the ability to archive digital images on the web or into medical records is becoming a standard of care. The days of the solo equine veterinarian doing it all are becoming a tradition of the past. Clients are more educated and aware of new medical advances, and they are beginning to demand that their horses receive the very best medical care available—and that includes staff. The veterinary technician plays an important role in an equine practice being able to offer that level of care and medical expertise to clients.

The veterinary technician in an equine practice is a valuable investment. They can save you time, which saves you money; they can perform laboratory and other diagnostic procedures that increase income centers; they can allow you to concentrate on the aspects of veterinary medicine that you enjoy and should focus on such as diagnosing, prescribing, performing surgery and communicating with clients so you experience less burnout; and they can be your partner, teammate and support system in addition to being your veterinary assistant, nurse and technician. It may take investment of time, money, guidance and professional mentoring, but the rewards and the possibilities are many.

You may ask, where do I find a technician who has all of these qualities? You may only need to cultivate and encourage one of your present support staff, or you may need to search outside your practice for a technician who is qualified in the areas your practice needs.

Consider what your day would be like if your technician was allowed, encouraged and shown how to do all of these tasks for you so you didn't have to do it all: You arrive at 9:00 a.m. and all of your hospitalized patients have been examined, their treatments (per your instructions) have been completed, their records updated and an overview of their status is ready for your review. You order the lab work and the diagnostic procedures. While you are making phone calls and checking the appointment book, the procedures are carried out. Your appointments arrive and your technician makes sure the client paperwork is correct and has anticipated your needs by gathering all the equipment, medications and supplies needed for the procedures. You visit with the client while the technician performs the physical exam and takes a brief history. The technician takes the X-rays, assists with the lameness exams or the ultrasounds and you are free to visit with the client further or start your next appointment. You then have your first surgery and the technician has prepared the patient for surgery, all records and X-rays are ready for your review, the pre-surgical lab work has been done, the surgical packs and anesthesia equipment are ready and the horse is on the table ready for you to perform surgery. Upon completion, you leave to talk to the client, and the horse is bandaged, recovered and monitored.

For your farm call, the technician drives so you can make calls and review records. At the farm, the technician gets all the medications and equipment ready, assists you, puts everything back in its place, and then prepares the invoice and collects the bill. On the way home, the technician enters all the data into the medical records or on your day log, updates your appointment book and schedules recalls. Once back at the clinic, the technician develops the X-rays and then restocks the truck for the next call. It is 4:00 p.m. and after checking on all the hospitalized cases, you leave for the day knowing the technician will take care of the treatments, monitor the status of the surgery patient, call you with an update and prepare for the next day.



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Now imagine what your day would be like if you did not have a technician doing all or most of these tasks for you. Surveys have shown that employing and utilizing a credentialed veterinary technician can increase your bottom line by about $50,000.

Deborah Reeder is executive director of the American Association of Equine Veterinary Technicians and Assistants.

5 things to know about AAEP this month

1. The Infectious Disease Committee has published ongoing prevention measures for COVID-19 in equine practice. Download at https://tinyurl.com/idccov19.
2. Acquire up to 16 hours of CE in August on performance-related case management by registering for the AAEP's Virtual CE Summer Series at aaep.org/meetings.
3. Save $200 on your convention registration and $50 per night on your hotel by taking advantage of Sept. 15 early-bird rates at convention.aaep.org.
4. U.S. members: Reserve your spot for reimbursement of up to $600 for compassionate care of at-risk horses. Learn more at aaep.org/vet-direct-safety-net.
5. Work with clients and law enforcement to prevent equine abuse and neglect using AAEP resources available at aaep.org/owner-guidelines/equine-welfare.

New Practice Life podcast disputes the negative perception of equine practice

With more practices becoming "youth friendly" and the job market tilting toward applicants, the future of equine veterinary practice may not be as grim as widely reported.

In the latest episode of the AAEP Practice Life podcast, entitled "Equine Practice is Pretty Good," host Dr. Mike Pownall discusses practice culture and tips for new veterinarians to achieve sustainable and enjoyable careers with guests Dr. Lisa Kivett, owner of Foundation Equine Clinic in Southern Pines, N.C., and Dr. Mitchell Rode, owner of Clarke Equine Wellness and Performance in Berryville, Va.

Among their advice, Drs. Kivett and Rode encourage new veterinarians to define their own boundaries and ideas of success before seeking out practices whose cultures align with their individual ideals. Download or listen to the 31-minute episode at podcast.aaep.org.

CONTINUING EDUCATION

Dr. John A.E. Hubbell to probe means of enhancing anesthesia safety during Milne Lecture

Dr. John A.E. Hubbell

Since dawn of the modern era of equine anesthesia and analgesia in the 1960s, significant advances have been driven by the development of complex surgical procedures and advanced imaging modalities that required extended periods of general anesthesia. Despite the many advances, however, anesthesia of the horse remains more perilous than anesthesia of the other domestic species.

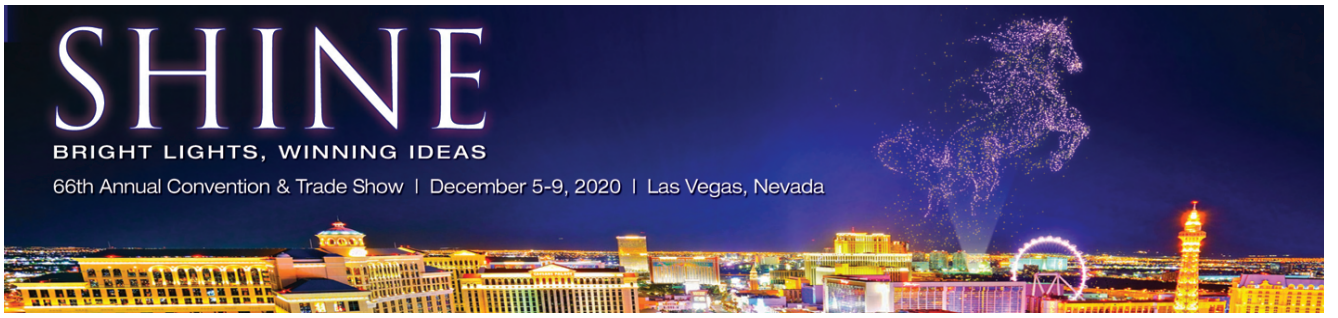
During his Dec. 7 Frank J. Milne State-of-the-Art Lecture, "Moving Equine Anesthesia from an Art toward a Science," acclaimed veterinary anesthesiologist Dr. John A.E. Hubbell will trace the development of modern anesthetic methods, identify current best practices and areas of needed improvement, and postulate pathways for enhancing the safety of equine anesthesia in the future.

Dr. Hubbell is the chief of anesthesiology at Rood and Riddle Equine Hospital in Lexington, Ky., and holds the title professor emeritus of veterinary clinical sciences at The Ohio State University College of Veterinary Medicine. He's been a Diplomate of the American College of Veterinary Anesthesia and Analgesia since 1982.

After receiving his veterinary degree from Ohio State in 1977, Dr. Hubbell served an equine surgery internship at the University of California, Davis before returning to Ohio State as a resident in veterinary anesthesiology. He served on faculty at Ohio State from 1982 until 2015, when he joined Rood and Riddle.

Dr. Hubbell is author of numerous articles on veterinary anesthesia and co-author of two textbooks: *Handbook of Veterinary Anesthesia* and *Equine Anesthesia Monitoring and Emergency Therapy.* He speaks frequently on the topic at the AAEP Annual Convention and at other conferences and meetings.

The convention lecture, sponsored by Platinum Performance, is named for AAEP past president and distinguished life member Dr. Frank J. Milne.



Immerse in experiential learning at convention labs

Expand your skill set with hands-on instruction during the slate of wet and dry lab offerings at the AAEP's 66th Annual Convention, Dec. 5–9 in Las Vegas, Nev.

Each lab has an attendance cap to create an optimal learning experience, and lab registration is on a first-come basis. Register for one or more labs when completing your convention registration at convention.aaep.org or by calling the AAEP office at (859) 233-0147.

Wet Labs

Wet labs will be held at the Viticus Center – Oquendo Campus, approximately five miles from Mandalay Bay.

1. Essential Techniques for the Ultrasound Exam of the Equine Back and Hind Proximal Suspensory
presented in conjunction with ISELP
Saturday, Dec. 5
Session 1: 8:00 a.m.-noon
Session 2: 12:30-4:30 p.m.
Cost: $450 for AAEP/ISELP members
Attendance cap: 50 per session

Explore the complex anatomy and ultrasound challenges of the equine back and hind proximal suspensory ligament. Clinical cases will be discussed and approaches to diagnosing injuries and treating the equine athlete investigated with leading clinicians in this field.

2. Advanced Treatment of Equine Periodontal Disease
Saturday, Dec. 5
8:00 a.m.-5:00 p.m.
Cost: Check website or call for pricing
Attendance cap: 24

Acquire the knowledge and skills necessary to use specific odontoplasty burring techniques to treat various types of pathological diastema in periodontal disease. The morning session will consist of classroom instruction; the afternoon session will be a cadaver wet lab.

Clinical Skills Dry Labs

Sunday, Dec. 8, Mandalay Bay Convention Center
Session 1: 10:00 a.m.-noon
Session 2: 1:00-3:00 p.m.
Session 3: 3:30-5:30 p.m.
Cost: $250 per session
Attendance cap: 12 per lab session

Enhance patient care by learning a new clinical technique or refreshing your existing skill set. All labs will be offered during each of the three sessions; register for up to three of the following labs:

Lab A: Tendon Sparing Navicular Bursa Injection

Lab B: Tips on Collection, Processing and Interpretation of Endometrial Culture and Cytology

Lab C: Ultrasound-Guided Spinal Joint Injections

Lab D: Practical Skills in Podiatry

Visit **convention.aaep.org** for additional information or to register.

Crack the code: Virtual CE series to help you maximize performance-related case outcomes

Providing a new and engaging learning experience for members, the AAEP is excited to present 16 hours of online RACE-approved (pending) continuing education throughout August on interdisciplinary diagnostic, therapeutic and rehabilitative strategies for the performance horse.

Under program chair Dr. Sherry Johnson, the AAEP Virtual CE Summer Series, "Cracking the Performance Horse Code: Interdisciplinary Strategies to Maximize Clinical Outcome," will consist of a weekly pair of live, interconnected two-hour sessions beginning Aug. 4 and concluding Aug. 27. Each online session will feature a dynamic group of presenters whose insight on real-world case examples will highlight the collaboration that occurs between specialists and practitioners to maximize clinical success in difficult performance-related scenarios.

Live attendees are encouraged to participate in the real-time discussions and Q&A periods. Sessions will also be available on demand for those unable to attend any of the live sessions. Supplemental resources such as discussion forums, scientific papers, images and video clips will be available in advance of each session.

A weekly program synopsis follows; view the complete program and register for the series at the AAEP member rate of $399 at aaep.org/meetings.

WEEK 1: Surgery Meets Sports Medicine: To Operate or Not?

Session 1: Tuesday, Aug. 4, 5:00-7:00 p.m. ET
Session 2: Thursday, Aug. 6, 5:00-7:00 p.m. ET

Navigate the surgical decision-making process and explore currently reported outcomes and approaches for a variety of orthopedic lesions in addition to learning about lesion accessibility and expected prognoses.

Presenters:
Moderator: Beau Beck, DVM
Surgeon: Kati Glass, DVM, DACVS (LA)
Sports Medicine Specialist: Sarah Sampson, DVM, Ph.D., DACVS (LA), DACVSMR

WEEK 2: Imaging Meets Sports Medicine: The Complexities of Navigating the Diagnosis

Session 1: Tuesday, Aug. 11, 5:00-7:00 p.m. ET
Session 2: Thursday, Aug. 13, 5:00-7:00 p.m. ET

Gain out-the-door strategies to maximize imaging bandwidth, navigate cases with advanced imaging findings and tackle the curveball diagnosis through interactive case examples and panel discussion.

Presenters:
Moderator: Luke Bass, DVM, MS, DABVP
Imaging Specialist: Kurt Selberg, DVM, MS, DACVR
Sports Medicine Specialist: Katie Seabaugh, DVM, MS, DACVS, DACVSMR

DRS Photography

The AAEP's new virtual CE series will underscore the importance of collaboration in tackling difficult performance-related cases.

WEEK 3: Internal Medicine Meets Sports Medicine: Working Together to Manage the Equine Athlete

Session 1: Tuesday, Aug. 18, 5:00-7:00 p.m. ET
Session 2: Thursday, Aug. 20, 5:00-7:00 p.m. ET

Learn key management strategies for the horse with neurologic, muscle-related, airway or other considerations, with special focus on management of complicated cases.

Presenters:
Moderator: Jackie Christakos, DVM
Internist: Amy Johnson, DVM, DACVIM (LAIM & Neurology)
Sports Medicine Specialist: Elizabeth Davidson, DVM, DACVS, DACVSMR

WEEK 4: Rehabilitation Meets Surgery: From the OR Back to the Arena – Strategies to Minimize Time Out of Competition

Session 1: Tuesday, Aug. 25, 5:00-7:00 p.m. ET
Session 2: Thursday, Aug. 27, 5:00-7:00 p.m. ET

Review cutting-edge rehabilitative strategies being used to optimize recovery and reduce reinjury rates from a variety of orthopedic procedures.

Presenters:
Moderator: Craig Lesser, DVM, CF
Surgeon: Lauren Schnabel, DVM, Ph.D., DACVS, DACVSMR
Rehabilitation Specialist: Caitlyn Redding, DVM

The AAEP thanks series' sponsors:

Week 2 Hallmarq Advanced Veterinary Imaging

Week 3 Boehringer Ingelheim

Week 4 EQUITHRIVE

Register for the series or learn more at **aaep.org/meetings**

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44 members attain Honor Roll status

Recognizing the longstanding commitment to the veterinary medical profession and to the association, the AAEP has conferred Honor Roll status upon 44 veteran members during the preceding 12 months. The Honor Roll membership category is reserved for members who have reached the age of 70 and have maintained an AAEP membership for 40 years. Congratulations to the following members who attained this milestone between July 1, 2019, and June 30, 2020:

Dr. Hugh J. Baird, Hampton, NB, Canada
Dr. James L. Baum, Shelbyville, TN
Dr. Eddy A. Behrens, Ocala, FL
Dr. David S. Bogenrief, San Miguel, CA
Dr. Vincent A. Brencick, Bossier City, LA
Dr. Lawrence A. Butler, Kemptville, ON, Canada
Dr. John A. Chris, Toronto, ON, Canada
Dr. Don D. Connally, Ada, OK
Dr. James O. Cook, Lebanon, KY
Dr. Barbara G. DeLaney, Brick, NJ
Dr. Keith I. Douglas, Sarnia, ON, Canada
Dr. James R. Dysart, Parker, CO
Dr. Richard Estes, Ocala, FL
Dr. Mark R. Fitch, Boulder, CO
Dr. Donna R. Franchetti, West Chester, PA
Dr. Forrest G. Franklin, Sloughouse, CA
Dr. Gary R. Friederich, Palos Park, IL
Dr. Carol L. Gillis, Aiken, SC
Dr. Charles L. Kidder, Lexington, KY
Dr. Martin C. Langhofer, South Bend, IN
Dr. Ronald E. Leick, Alexandria, KY
Dr. James F. Leonard, Blissfield, MI
Dr. Nicholas G. Loutsion, Canonsburg, PA
Dr. Michael Mann, Grayslake, IL
Dr. James E. Meyer, Wendell, NC
Dr. John J. Migliore, Visalia, CA
Dr. James D. Mort, Red Hook, NY
Dr. Richard A. Mosier, Coburg, OR
Dr. Thomas J. Newton, Crozier, VA
Dr. Terry K. Paik, El Cajon, CA
Dr. Christopher E. Pankau, Los Olivos, CA
Dr. Jacquelyn J. Rich, Lott, TX
Dr. Edward Robinson, East Lansing, MI
Dr. Bradley S. Root, Albuquerque, NM
Dr. Robert K. Schneider, Newman Lake, WA
Dr. William J. Schumacher, Las Cruces, NM
Dr. Jerry L. Sellon, Goshen, IN
Dr. William F. Snyder, New Baltimore, MI
Dr. Michael Scott Spensley, Charles Town, WV
Dr. Ladd N. Squires, Parker, CO
Dr. James W. Temple, Sunbury, PA
Dr. Jean A. Trochet, Hendersonville, NC
Dr. Jeffrey N. Witwer, Camden, SC
Dr. Robert Glyn Wright, Belwood, ON, Canada

Dr. Scott Bennett, pioneering veterinarian and Saddlebred hall member, dies at 66


Dr. Scott Bennett

Dr. Scott Bennett, who pioneered breeding processes and lameness treatments that improved the lives, health and performance of countless show horses, died June 4 at age 66.

After receiving his veterinary degree from The Ohio State University in 1977, Dr. Bennett worked as resident veterinarian of a large breeding and training operation before starting Equine Services PSC in Simpsonville, Ky., in 1982. During his career, he carried out the first embryo transfer in the American Saddlebred, developed a viable surgical tubal (oviduct) patency and treatment in the equine species, developed endoscopic hysteroscopy and laser hysteroscopic treatment of the uterus, and pioneered treatments with IRAP and stem cells.

With his wife Linda, Dr. Bennett owned and operated Alliance Stud, which produced many champion American Saddlebred horses. His contributions to the Saddlebred industry as both breeder and veterinarian earned Dr. Bennett induction into the Saddlebred industry's World's Championship Horse Show Hall of Fame in 2017. He also received the American Saddlebred Horse Association's 2019 Lifetime Achievement Award.

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Wellness for Your Body

The mental and physical care of your own body is just as important as your care of your patients

By Amy L. Grice, VMD, MBA

Editor's Note: This article is reprinted with permission from AAEP Media Partner EquiManagement.

Physical health results from a combination of behavior, genes and access to good medical care. While we cannot change our genetic makeup, and our access to medical care will be influenced by where we live, we can exercise control over our behavior. We can make healthy choices about nutrition and exercise, plus control risky behaviors such as smoking and drinking.

Equine vets, like other workers in very physical jobs, have a higher risk for acute and chronic injuries. High levels of stress can encourage unhealthy habits. Taking care of your physical body can allow you to live a longer, happier life.

Good nutrition is the foundation for good health, and most veterinarians understand what constitutes healthy eating. Putting it into practice is harder!

Adopting a heart-healthy diet low in saturated fat and sugar and high in fiber, vegetables and lean protein can be difficult in the time-starved lifestyle of an equine doctor. It is infinitely harder to eat a salad than a sandwich while walking between stalls in the hospital or while driving an ambulatory vehicle.

Many equine veterinarians never sit down to eat breakfast or lunch unless they are behind the wheel. Often, they simply continue working until they are famished and irritable. This leads to scarfing down the first food they can find—which all too often is the box of donuts in the lounge or the slice of greasy pizza from the gas station. Feeding your body with respect for the finely-tuned organism that it is requires intention.

Consider packing a lunch (and a breakfast) of healthy foods such as yogurt, nuts, fruit, and/or leftover vegetables and meat/fish. Try to carve out 15 minutes to eat when you can experience the food you consume.

All the time spent behind the wheel or in the clinic can lead to weight gain because of inactivity. Stress also causes increased deposition of fat. Losing weight can be very difficult, so preventing gain is the best strategy. Exercise is important in this effort and is a great stress-reducer, as well.

Most practitioners working long days struggle to find time to exercise and must fit it in early in the morning or late in the evening. When on emergency duty, exercise often is impossible. However, new studies show that the recommended 30 minutes of daily moderate activity does not have to be achieved at one time; it can be spread throughout the day.

By adopting new habits of parking farther away from the front door of your office (or wherever you're going) and taking the stairs whenever possible, you will add steps that will add incrementally to your fitness. Consider leaving your work truck at the office at night and biking to work each morning. If you can, carve out time for a short walk in a pretty spot each day. These mini-vacations will benefit your spirit as well as your body.

How many equine veterinarians can relate to this photo?

Unhealthy habits such as smoking and excessive drinking are often linked to stress. These addictions can be very hard to stop, but the benefits to your health are considerable if you can. Seek help from your health provider or a local support group. Strategies to decrease your stress and increase your exercise are often very helpful.

Some of the highest risks to your physical health in the equine veterinary profession are traumatic injuries suffered during work. Kicking, striking and crushing are all defensive behaviors that horses exhibit when reacting to or being apprehensive about painful or uncomfortable procedures.

Most equine veterinarians are tough and shake off injuries that others would give time to heal. Commonly, they fail to seek diagnostic or treatment services from a medical doctor trained for *Homo sapiens*. Prevention is the key to minimizing injury.

In your work, utilize experienced handlers, position your body in as safe a place as possible, use sedation when appropriate, use needed levels of restraint and protect your head.

The trauma you suffer during practice when you are younger will often cause chronic pain as you age. Your body needs to last for many decades, if not a century. Treat it with respect and loving care to have the best chance at a long and healthy life.

AAEP HEALTHY Practice

Dr. Grice of Virginia City, Mont., is a former member of the AAEP board of directors and works as a business consultant to equine practices.

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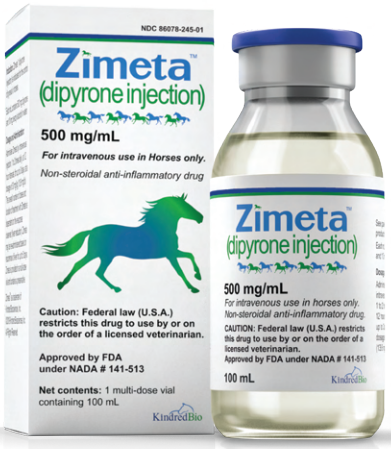

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References: 1. Zimeta™ (dipyrone injection). [Full Prescribing Information], Kindred Biosciences, Inc. (Burlingame, CA). Revised: 03/2019. **2.** Morresey PR, et al. Randomized blinded controlled trial of dipyrone as a treatment for pyrexia in horses. *Am J Vet Res.* 2019;80(3):294-299.

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Highlights of recent clinically relevant papers

Uveitis in donkeys

This study by Claire Bradley and colleagues in the UK investigated the prevalence of uveitis within a population of donkeys in the UK.

Donkeys admitted to two sanctuaries for reasons unrelated to vision underwent ophthalmic examination without sedation. A donkey was determined to have signs of uveitis if it displayed at least three of the following: miosis, corpora nigra atrophy, aqueous flare, keratic precipitates, corneal oedema, anterior lens capsule pigment ('iris rests'), cataract, iris pigmentary change, synechiae, lens luxation or subluxation, vitreal opacities, retinal detachment or traction bands, or peripapillary scarring. Donkeys were considered to have active uveitis if observable signs of intraocular inflammation were present.

A total of 207 donkeys were examined, ranging from 2 to 37 years (median 17 years). Signs consistent with previous or current uveitis were identified in eight eyes from six donkeys. Significant ocular pathology precluded detailed fundic examination in three eyes. Clinical signs included miosis (n = 1), corpora nigra atrophy (n = 6), anterior lens capsule pigment (n = 2), cataract (n = 8), posterior synechiae (n = 3), lens subluxation (n = 1), vitreal changes (n = 2), peripapillary scarring (n = 3), and phthisis bulbi (n = 1). Significant ocular pathology prevented fundic examination in three eyes. Three donkeys were considered to have active uveitis and three were post-inflammatory or quiescent. Of those displaying uveitic changes, 3/8 eyes were blinded by the pathology. The overall prevalence of uveitis in this population of donkeys was 2.9%. These results show a comparable disease prevalence to that reported for horses in the UK.

Cheek teeth extraction

This retrospective study by Rebekah Kennedy and colleagues in the UK describes the complications of equine cheek tooth exodontia techniques.

The clinical records of all cheek teeth extractions performed at the University of Edinburgh Veterinary School between February 2004 and September 2018 were examined. Owners were asked to complete a follow-up questionnaire regarding complications post-extraction.

In all cases, oral extraction was initially attempted prior to Steinman pin repulsion or minimally invasive transbuccal extraction (MTE). A total of 428 cheek teeth extractions were performed over the study period, 58 (13.6%) of which had complications post-extraction. The most frequent complication was the formation of intra-alveolar bony sequestra (32/58). The most severe post-extraction complications were seen in four horses that had swollen mandibles pre-extraction due to apical infections, who went on to develop severe mandibular osteomyelitis post-extraction. Two horses developed sinusitis following maxillary cheek teeth exodontia. Overall, the complication rate was 10.8% for oral extraction, 24.4% for Steinmann pin repulsion, 20% for standard repulsion and 25.6% for MTE. Post-extraction complications caused a longer-term clinical problem in 34/428 (7.9%) of horses and were asymptomatic or quickly self-resolving in the other 24 (5.6%) cases. Risk of developing a post-extraction alveolar disorder was increased following extraction of the mandibular 06s, 07s or 08s compared to all other cheek teeth combined; for cheek teeth with apical infections compared to those without; and following repulsion or minimally-invasive transbuccal extraction (MTE) than following oral extraction.

Oral extraction had the lowest risk of complications. Improved knowledge of the prevalence, types and risk of development of post extraction complications may help reduce these complications.

Septic synovitis

In this study Ludovic Miagkoff and colleagues in Canada described the antimicrobial susceptibility patterns of the most commonly isolated bacteria cultured from 131 synovial fluid samples from 108 horses with suspected septic synovitis treated at an equine referral hospital between 2008 and 2017.

Medical records were searched to identify horses with suspected septic synovitis and results of synovial fluid bacterial culture and antimicrobial susceptibility testing. Data collected included signalment, known or suspected origin of synovial contamination, synovial structures affected, antimicrobial treatment, and results of synovial fluid cytologic evaluation and bacterial culture and susceptibility testing. Horses were grouped as adults (≥6 months old) or foals (<6 months old).

Results of bacterial culture were positive for 34/70 (49%) of samples from 68 adult horses and 18/61 (30%) samples from 40 foals. Gram-positive bacteria were more common in adult horses, whereas Gram-negative bacteria were more common in foals. No multidrug-resistant micro-organisms were identified. For adult horses, 92% (23/25) of Gram-positive isolates tested with penicillin and gentamicin were susceptible to the combination. For foals, 94% (15/16) of isolates tested with penicillin, gentamicin, or both had susceptibility to one or both antimicrobials.

Periodic review of bacterial profiles and antimicrobial susceptibility in horses with septic synovitis can help to detect early changes in bacterial pressure and antimicrobial resistance. These findings suggested that in the region of Canada where this study was performed, a combination of penicillin and gentamicin would be an effective empirical antimicrobial treatment for most horses with septic synovitis while waiting for results of bacterial culture and susceptibility.

Veterinary use of artificial intelligence

This study by Mohammad Fraiwan and Sameeh Abutarbush from the Jordan University of Science and Technology investigated the use of artificial intelligence to predict survivability likelihood and need for surgery in horses presented with acute abdomen (colic).

Artificial intelligence and machine learning are widely used in the medical fields of diagnosis, imaging and laboratory testing procedures. This technology could be used with potentially successful outcomes and results in many areas of veterinary medicine. In this study, two critical

predictions were explored in horses presented with acute abdomen (colic) using this technology. Those were the need for surgical intervention and survivability likelihood of affected horses based on clinical data (history, clinical examination findings, and diagnostic procedures). The two prediction parameters were explored using the application of Decision Trees, Multilayer Perceptron, Bayes Network, and Naïve Bayes.

The machine learning algorithms were able to predict the need for surgery and survivability likelihood of horses presented with acute abdomen (colic) with 76% and 85% accuracy, respectively. The application of this technology in the different clinical fields of veterinary medicine appears to be of value and warrants further investigation and testing.

Body-mounted inertial sensor assessment

The objective of this study by Shannon Reed and colleagues in the USA was to compare results for initial body-mounted inertial sensor (BMIS) measurement of lameness in 1224 equids trotting in a straight line with definitive findings after full lameness evaluation.

Lameness measured with BMIS equipment while trotting in a straight line was classified into categories of none, forelimb only, hindlimb only, and eight patterns of combined forelimb and hindlimb lameness (CFHL). Definitive findings after full lameness evaluation were established and classified into types (no lameness, forelimb- or hindlimb–only lameness, CFHL, or lameness not localised to the limbs). Observed proportions of lameness type for each initial BMIS-assessed category were compared with hypothetical expected proportions through χ^2 goodness-of-fit analysis.

The most common initial BMIS-assessed lameness category was CFHL (693/1224; 56.6%), but this was the least common definitive finding (94/862; 10.9%). The observed frequency of no lameness after full lameness evaluation was greater than expected only when initial BMIS measurements indicated no lameness. The observed frequency of forelimb-only lameness was greater than expected when initially measured as forelimb-only lameness and for CFHL categories consistent with the diagonal movement principle of compensatory lameness. Observed frequency of hindlimb-only lameness was greater than expected when initially measured as hindlimb-only lameness and for CFHL categories consistent with the sagittal movement principle of compensatory lameness. Equids initially assessed as having no lameness had the highest (103/112; 92%) and those assessed as CFHL pattern 7 (forelimb with contralateral hindlimb impact-only lameness) had the lowest (36/66; 55%) rates of definitive findings.

These results of initial straight-line trotting evaluations with a BMIS system did not necessarily match definitive findings but may be useful in planning the remaining lameness evaluation.

Low-field MRI of the proximal suspensory region

In this prospective survey study Raphael Labens, based in Australia, and colleagues in France and the UK evaluated whether standing low-field MRI of the equine proximal metacarpal/metatarsal region is considered useful for diagnosing primary bone pathology and makes a positive contribution to case management.

High-field MRI of the proximal metacarpal/metatarsal region has been associated with great diagnostic potential and clinical reports of standing low-field MRI of the forelimb suggest the same. In this survey users of a widely available system were questioned on their experience, operating procedures, and interpretation of standing low-field MRI findings of the proximal suspensory region. Response data included scores on a modified Likert scale from which weighted ratings were calculated for statistical analyses.

Responses were obtained from 17 to 29 of the 38 invited facilities, depending on the question. Users indicated that standing low-field MRI was most frequently performed in the face of equivocal diagnostic findings; compared to sports horses, general purpose riding horses were thought less likely to have detectable abnormalities and standing low-field MRI was rated most useful for the detection of primary bone pathology in the proximal metacarpal region. Standing low-field MRI signal change involving both the suspensory ligament and adjacent bone concurrently was rated most relevant and abnormalities solely affecting the muscle/adipose tissue bundles least relevant for diagnosing suspensory ligament injury. Transverse scans and (in decreasing order) T1-weighted gradient echo, short-tau inversion recovery FSE, T2*-weighted gradient echo, and T2-weighted FSE sequences were the most frequently acquired and judged most useful by the majority of users experienced in imaging of the target area. This survey supports the relevant impact of standing low-field MRI on clinical case management, particularly in the context of imaging the proximal metacarpal region.

S. WRIGHT
EVE Editorial Office

References

Bradley, C., Grundon, R. and Sansom, P.G. (2020) The prevalence of uveitis in a population of donkeys in the UK. *Equine Vet. J.* https://doi.org/10.1111/evj.13257. [Epub ahead of print].

Fraiwan, M.A. and Abutarbush, S.M. (2020) Using artificial intelligence to predict survivability likelihood and need for surgery in horses presented with acute abdomen (colic). *J. Equine Vet. Sci.* https://doi.org/10.1016/j.jevs.2020.102973. [Epub ahead of print].

Kennedy, R., Reardon, R.J.R., James, O., Wilson, C. and Dixon, P.M. (2020) A long-term study of equine cheek teeth post-extraction complications: 428 cheek teeth (2004–2018). *Equine Vet. J.* https://doi.org/10.1111/evj.13255. [Epub ahead of print].

Labens, R., Schramme, M.C., Murray, R.C. and Bolas, N. (2020) Standing low-field MRI of the equine proximal metacarpal/metatarsal region is considered useful for diagnosing primary bone pathology and makes a positive contribution to case management: a prospective survey study. *Vet. Radiol. Ultrasound* **61**, 197-205.

Miagkoff, L., Archambault, M. and Bonilla, A.G. (2020) Antimicrobial susceptibility patterns of bacterial isolates cultured from synovial fluid samples from horses with suspected septic synovitis: 108 cases (2008–2017). *J. Am. Vet. Med. Assoc.* **256**, 800-807.

Reed, S.K., Kramer, J., Thombs, L., Pitts, J.B., Wilson, D.A. and Keegan, K.G. (2020) Comparison of results for body-mounted inertial sensor assessment with final lameness determination in 1,224 equids. *J. Am. Vet. Med. Assoc.* **256**, 590-599.

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Editorial

Equine orthopaedics and lameness

Introduction

Lameness (defined as an abnormal stance or gait caused by a structural or functional abnormality of the locomotor system) continues to be a frequent cause of poor performance and the commonest reason for time off work among athletic horses. It is a clinical sign, not a disease per se, and is a manifestation of pain, mechanical dysfunction, or neuromuscular deficit causing an alteration of gait. Numerous clinical and research studies have been undertaken and published over the past hundred years that have contributed to our understanding of the aetiology, pathogenesis, diagnosis and treatment of conditions that result in lameness, and more studies continue today. This month, *Equine Veterinary Education* has released an online collection of original studies on equine orthopaedics and lameness that provide clinicians with a wealth of clinically relevant information about many of the diseases that cause lameness.

Diseases and injuries of both the appendicular and axial skeleton can result in lameness and gait abnormalities. Within the appendicular skeleton, the distal limb is a frequent site of disease and, not surprisingly, the largest group of articles in this series relate to this critically important area. This includes articles highlighting the role of diagnostic imaging (including radiography, magnetic resonance imaging (MRI) and computed tomography), as well as reports of surgical techniques and medical therapies, and studies of specific diseases, including ossification of the ungular cartilages, quarter cracks, distal phalanx fractures and tropical joint syndrome. The series also contains two important studies that relate to diagnostic imaging of another key area of the appendicular skeleton, namely the stifle: a study showing the changing appearance of radiographic abnormalities including osteochondrosis of the trochlear ridges and subchondral lucencies of the medial femoral condyle of young Thoroughbred horses, and a description of the technical aspects and common findings relating to MRI of the stifle. The efficacy of a novel treatment for subchondral cystic lesions in the stifle and other joints using parathyroid hormone peptide is assessed in another dose-blinded randomised study. The hock and suspensory ligament constitute yet further clinically important area, and two articles in the series provide important new clinical information about suspensory ligament damage.

Conditions affecting the back and sacroiliac regions are frequently suspected in horses presenting with poor performance or lameness, and several articles in this series provide further information about the diagnosis and outcomes of horses affected by such disorders. These include an analysis of the value of diagnostic ultrasound of the lumbosacral region, complications associated with diagnostic analgesia of the sacroiliac joint region and the outcomes for horses diagnosed with sacroiliac region pain. In addition, two articles focus on the highly important issues of saddle fit and rider size.

Recent studies have demonstrated that the presence of behavioural signs of pain can be usefully employed to identify musculoskeletal pain in ridden horses, and these studies have led to the development of a ridden horse ethogram that can be effectively used to differentiate lame from nonlame horses. Two articles in the series provide further important information about the value of the ridden horse ethogram to veterinarians undertaking lameness evaluations. The potential value of the ridden horse ethogram in investigating horses with lameness and gait abnormalities originating from diseases of the cervical spine, including possible caudal cervical and cranial thoracic nerve root injury, is described in another study.

We hope that this collection of articles will provide our readers with a unique resource that highlights current developments and knowledge of key areas relating to equine orthopaedics and lameness. It supports our aims to disseminate information and research findings that have direct clinical relevance to equine clinicians around the world. Further online collections of original studies relating to other areas of equine veterinary practice are planned for 2020.

Radiographic assessment of the ratio of the hoof wall distal phalanx distance to palmar length of the distal phalanx in 415 front feet of 279 horses

Mullard *et al.* (2020)

Determination of the ratio of the hoof distal phalanx distance (HDPD) to the length of the palmar aspect of the distal phalanx (HDPD ratio) may be helpful for the diagnosis of laminitis. Estimates for normal values have varied ($\leq$0.25 to $\leq$0.30) and been based on small numbers of horses. No study has compared external characteristics of the hoof wall and HDPD ratio. The objective was to document the HDPD ratio in a large number of horses/ponies of various breeds, and to assess relationships between signalment and hoof level factors and the HDPD ratio and height:bodyweight ratio. This retrospective study included 415 feet from 279 horses with foot pain and no known history of laminitis, or clinical signs of acute laminitis. Lateromedial radiographs were assessed; the HDPD and palmar length of the distal phalanx were measured digitally, and the ratio was calculated. The presence of divergent growth rings was determined from lateromedial photographs. Factors associated with HDPD ratio were assessed using linear mixed effects models, built using a stepwise backward elimination procedure with horse included as a random effect, and the final model was selected based on Akaike information criterion. The mean HDPD ratio was 0.25 $\pm$ 0.03 (median = 0.25; IQR 0.23–0.26; range 0.19–0.36). 42.2% of feet had a HDPD ratio >0.25. There was no significant difference in median HDPD ratio for feet with divergent growth rings compared with those without ($P = 0.16$). In the final mixed effects model, HDPD ratio decreased with increasing age (coefficient −0.0014; $P = 0.008$) and with increasing height:bodyweight ratio (coefficient −0.13; $P = 0.02$) and was greater in Cob breeds (coefficient 0.02; $P = 0.001$) compared with Warmbloods. However, this model only explained approximately 8.4% of HDPD ratio variability.

Magnetic resonance imaging characterisation of lesions within the collateral ligaments of the distal interphalangeal joint – 28 cases

Beasley *et al.* (2020)

Collateral ligament (CL) desmopathy of the distal interphalangeal joint (DIPJ) is a known injury that is not uncommonly diagnosed in horses presenting for lameness isolated to the foot. Ultrasonography and radiography are often used as primary diagnostic tests with mixed success. Medical records of horses undergoing magnetic resonance imaging (MRI) of the foot between November 2007 and October 2015 were reviewed. Horses were included only if the MRI followed an examination that localised a component of the lameness to the foot, and the MRI study indicated that CL desmopathy of the DIPJ was the most important finding. Thirty-four limbs from 28 horses were included, and 48 CL desmopathies were identified. Of the 48, 27 were distal to the coronary band, 15 were proximal to the coronary band, five lesions involved the entire ligament, and one CL had proximal and distal focal lesions. Twenty-four of the 28 horses were able to return to work. There was no significant association between severity or lesion location and time to return to work. This study confirms that a high proportion of CL lesions of the DIPJ are located distal to the coronary band and require MRI for an accurate diagnosis that would otherwise be missed by ultrasound examination alone.

Quarter cracks in Thoroughbred racehorses trained in Hong Kong over a 9-year period (2007–2015): incidence, clinical presentation and future racing performance

McGlinchey *et al.* (2020)

A quarter crack is a defect of the hoof wall that is caused by a combination of factors that affect the quality of the hoof horn. To date, no peer-reviewed studies have described the incidence of quarter cracks in Thoroughbred racehorses during training. Further, there is limited information regarding the clinical presentation and racing performance following a quarter crack. Therefore, the objectives of the current study were to describe the incidence, clinical presentation and outcome of quarter cracks sustained by horses in racing and training at the Hong Kong Jockey Club. Horses with quarter cracks that required attention from a farrier and/or veterinarian were identified using farrier and veterinary clinical records. Data were described, including the affected foot, presence of lameness, treatment, reoccurrence and racing data for case and control horses. There was no significant difference between case and control horses for total career length, and the total number of starts, wins and places. Seventy-four horses experienced at least one quarter crack during the study period, for a total of 114 quarter cracks. Half of the horses experiencing a quarter crack were not lame on presentation. Most quarter cracks occurred in the right fore (n = 56/102; 54.9%) and in a medial position (n = 90/102; 88.2%). Horses returned to racing a median of 50 days after the first treatment, for a median of 18 starts. Six horses retired due to the occurrence of a quarter crack. Although the incidence of quarter cracks in racehorses is low and the majority of horses returned to a racing career comparable to unaffected horses, the reoccurrence rate is high, putting an emphasis on ongoing hoof management and farrier care to help prevent the reoccurrence.

Extensive ossification of the ungular cartilages and other osseous abnormalities of the proximal and distal phalanges

Tivey *et al.* (2020)

Ossification of the ungular cartilages of the equine foot has been well documented. There is growing evidence to suggest that extensively ossified cartilages (≥grade 4) can be associated with injury, pain and lameness. The objectives of this study were to describe the locations and extent of new bone on the proximal and distal phalanges and to determine the frequency of occurrence related to the ossification grade of the ungular cartilages. It was hypothesised that new bone formation would be seen more commonly in horses with grades ≥4 ossification than those with ossification of grade ≤3. Data were collected from 929 sets of images from individual limbs of 589 horses. Logistic regression modelling was used to indicate predictor variables that were significant. In 15.4% of limbs, there was grade 4 or 5 ossification of one or both ungular cartilages. New bone formation was seen on the palmaromedial and palmarolateral aspects of the diaphyseal and distal metaphyseal regions of the proximal phalanx in 28.7% of limbs. New bone formation was seen on the dorsal, dorsomedial and dorsolateral aspects of the distal phalanx, midway between proximal and distal in 7.2% of limbs. New bone formation was seen more commonly on the proximal phalanx ($P \leq 0.002$) and the distal phalanx ($P \leq 0.042$) in feet with grade ≥4 ossification of the ungular cartilages than in feet with ossification grade ≤3. Thoroughbred (odds ratio [OR] 0.398) and Warmblood (OR 0.522) breeds had a lower risk of new bone formation on the proximal phalanx compared with other breeds. Increasing age was a risk factor for new bone formation on the proximal phalanx (OR 1.092) but was associated with reduced risk of new bone on the distal phalanx. New bone formation on the proximal and distal phalanges may contribute to pain and lameness.

Management of chronic foot lameness with 2% ammonium chloride on the palmar digital nerves

Dau *et al.* (2020)

This case series describes the analgesic effect of 2% ammonium chloride (2% AC) in horses with chronic foot pain. Ten horses with foot pain related to chronic laminitis (n = 1), bruised sole (n = 1), distal interphalangeal joint (DIPJ; n = 1), podotrochlear apparatus (PA; n = 4) and PA associated with DIPJ (PA + DIPJ; n = 3) received perineural injections with 3 mL of 2% AC on the palmar digital nerves. Five horses with pain related to PA + DIPJ (n = 3), PA (n = 1) and DIPJ (n = 1) were treated with saline as control. The analgesic effect was evaluated as lameness improvement (LI) rate (%) using a body-mounted inertial sensor system and was assessed at 5, 12, 19, 35, 47 and 62 days after treatment. Horses treated with 2% AC demonstrated a mean LI rate above 50% from Day 12 (63% ± 26) to Day 62 (65% ± 26). Control horses had an overall LI of 28% (± 23%), and a LI above 50% was evidenced in horses with PA + DIPJ (n = 2) and PA pain (n = 1) at different times. Horses with PA pain presented higher LI rates (72% ± 23) than that presented by horses with PA + DIPJ (51% ± 9) or DIPJ (51% ± 19). Horses with severe

radiographic lesions of the navicular bone and DIPJ had the lowest LI rates after treatment. The 2% AC is a useful treatment to be included in the clinical management of chronic foot pain involving the podotrochlear apparatus with mild radiographic lesions.

Guillotine versus pull-through technique for palmar digital neurectomy: A retrospective study on 40 horses

Oosterlinck *et al.* (2020)

Palmar digital neurectomy (PDN) is used in horses for treating chronic foot pain refractory to other treatments and is most often performed using the guillotine technique or the pull-through technique. This study was performed to compare the outcome of the guillotine technique and the pull-through technique for PDN. Medical records of horses undergoing PDN (January 2008–February 2017) were reviewed (guillotine technique: n = 25, pull-through technique: n = 15). Outcome was obtained by telephone questionnaire. There was no significant difference between treatment groups for the return to athletic activity, presence of residual/recurrent lameness, occurrence of post-operative complications and owner satisfaction. Outcome was similar for both techniques, albeit with highly variable individual responses. Establishing realistic client expectations is very important because only a proportion of horses remain sound following PDN as time progresses. Adequate case selection is warranted with either technique and should involve accurate localisation of pain with diagnostic anaesthesia and definitive diagnostic imaging techniques.

Comparison of 3D-assisted surgery and conservative methods for treatment of type III fractures of the distal phalanx in horses

Heer *et al.* (2020)

The aim of this retrospective study was to compare the outcome of conservative methods and 3D-assisted surgery for treatment of type III fractures of the distal phalanx with regard to recovery time and the development of osteoarthritis (OA) in the distal interphalangeal joint (DIPJ). The medical records of all horses with type III fracture of the distal phalanx referred to the Equine Department, Vetsuisse Faculty, University of Zurich, between 1992 and 2016 were reviewed. The severity of lameness at initial examination, radiographic evaluation, treatment (conservative, group A; 3D-assisted surgery, group B), complications, outcome and recovery time was determined. Follow-up examinations included clinical and radiographic examinations. Of 33 horses, 15 received conservative treatment and 18 underwent surgery. Eleven of the 15 (73.3%) horses in group A returned to their intended use, and four were subjected to euthanasia or remained chronically lame. The median recovery time was 240 days (95% CI 180–374). Thirteen of 15 (86.7%) horses developed OA of the DIPJ within 5 months of the fracture. In group B, 16 of 17 (94.1%) horses returned to their intended use, one horse remained chronically lame, and one horse was subjected to euthanasia because of unrelated reasons. The median recovery time was 139 days (95% CI 120–270), and seven horses (38.9%) developed OA of the DIPJ within 5 months of the fracture. Overall, the screws had to be removed in five fluoroscopic-assisted surgery cases (three because of implant infection and two because of severe lameness), in one computer-assisted surgery case due to severe lameness and in one computed tomography-assisted surgery case because of implant infection. In conclusion, there was no significant difference in time for recovery of type III fractures of the distal phalanx between the two groups, but surgical treatment led to significantly fewer cases of OA in the DIPJ as determined by subjective radiographic evaluation (P = 0.015).

An investigation into the association between plantar distal phalanx angle and hindlimb lameness in a UK population of horses

Clements *et al.* (2020)

Low heels are the most common hoof conformational abnormality seen in both the front and hind feet of horses. A low/negative distal phalanx angle in the front feet has been associated with palmar heel injuries but only recently has the significance of low/negative angles in the hind feet received attention. A study including a greater number of horses more representative of the UK horse population would be useful to UK equine practitioners. Our null hypothesis was that the plantar distal phalanx angle does not differ between horses with and without hindlimb lameness. For this prospective case-controlled study, horses presenting for orthopaedic complaints underwent a complete lameness assessment. The plantar distal phalanx angulation (PDPA), the angle between a line parallel to solar surface contacting the ground and the solar margin of the distal phalanx, was calculated from lateromedial radiographs. Horses were included in the study if hindlimb lameness was definitively localised by diagnostic anaesthesia. Student's *t* tests and multivariable linear regression models were used for statistical analysis. One hundred and eighty-two horses met the inclusion criteria, 132 with hindlimb lameness and 50 controls. The mean left PDPA for HLL group was −1.0° vs. +1.8° for the controls. The mean right PDPA for HLL group was −1.1° vs. +1.4° in controls (both P<0.001). Lameness was most frequently localised to the stifle (59% of horses), followed by the distal tarsal joints and the proximal suspensory region. A limitation of the study was that the control group included some forelimb lame horses. It was concluded that horses with hindlimb lameness, including lameness localised to the stifle, were more likely to have negative PDPAs. While Pezzanite *et al.* (2019) previously reported a relationship between negative/neutral PDPA and tarsal/metatarsal lameness, this study is the first to find a relationship with stifle lameness, which may reflect differences in the populations of horses examined. Further kinematic studies are required to determine whether it is a cause or effect relationship.

Tropical joint syndrome: Exostosis on the dorsal aspect of the proximal phalanx in racing Thoroughbreds in Asia

Shaw and Rosanowski (2020)

Tropical joint syndrome (TJS) is poorly documented in the published literature but appears to be associated with horses undergoing intensive training in tropical areas: South-East Asia and Northern Australia. Tropical joint syndrome is characterised by a firm, often nonpainful swelling at the front of the fetlock, which has a slow and insidious onset. Swelling

associated with TJS can reach an alarming size, with a marked loss of fetlock flexion. Radiographs reveal varying degrees of exostosis, initially on the dorsolateral aspect of proximal phalanx (P1) but, as the condition progresses, onto the dorsomedial P1 and distal dorsal third metacarpal bone. A survey of equine veterinarians employed in racing practices in South-East Asia and Australia (n = 10) was undertaken to estimate the prevalence of this condition and treatment methods. Additionally, a retrospective study of clinical records was undertaken at the Singapore Turf Club to identify horses with TJS, with racing performance post-diagnosis compared with matched controls. All 10 racing veterinarians responded to the survey. All respondents recognised TJS in horses in their practice as 'new bone deposits of unknown origin', with most estimating prevalence between 1 and 10% in their population of horses. The most common treatment for TJS was intra-articular medication (n = 9) and/or shockwave therapy. In total, 79 horses had TJS diagnosed by equine veterinarians at the Singapore Turf Club between 2008 and 2015, 64 of which had complete race records. There was no significant difference in racing performance between horses with and without TJS. However, 29 cases that were retired from racing were retired with chronic, severe and irreversible fetlock pain. The high number of horses retired with fetlock pain due to TJS is a welfare concern. More research is required to identify management and treatment strategies to aid in dealing with this condition.

Tenoscopic resection of the manica flexoria in 21 horses using a two-portal unilateral technique

Diekstall *et al.* (2020)

Tears of the manica flexoria are a well-known cause of lameness in horses, and endoscopic resection using a 3- or 4-portal approach has a good success rate. This article describes the feasibility of a two-portal technique to resect the *manica flexoria* based on cadavers and a prospective clinical study. This technique is less invasive regarding the number of portals, allows more precise instrument handling as all sharp instruments used to transect the *manica flexoria* are always under visualisation and has reduced ergonomic risks for the surgeon compared with the multiple portal approaches. Fifteen of the 21 (71%) operated horses returned to preinjury level, comparable to the results obtained with previous techniques.

A detailed radiographic description of the nutrient foramen of the dorsal cortex of the proximal phalanx in horses

Frietman *et al.* (2020)

The purpose of this study was to provide a detailed radiographic description of the nutrient foramen (NF) of the dorsal cortex of the proximal phalanx (PI) which may aid the veterinary practitioner in identification of the NF and subsequently prevents misinterpretation of this radiographic finding. Medical records of 190 horses (116 Standardbreds, 64 Warmbloods and 10 Friesians) presented for standard radiographic screening were retrospectively reviewed. All four lateromedial radiographs of the metacarpophalangeal (MCP) and metatarsophalangeal (MTP) joints were evaluated for presence, localisation and trajectory of a dorsal NF by a registered radiologist and a surgical resident. In 27.5% (209/760) radiographs, a full-cortex NF was identified. The Standardbred-group represented the majority with 30% (138/464) diagnosed NF, followed by the Warmblood-group with 26% (66/256) NF and the Friesian-group with 13% (5/40) NF. Most NF had a unilateral distribution (62%). Fifty per cent of the NF entered the dorsal cortex at 47.4–59.2% of the total dorsal length of PI. Four different trajectory types were noted: a sigmoid-shaped course (44%), a straight course (33%), a palmar/plantar-curved course (14%) and a dorsal-curved course (9%). The consistent entrance location of the NF into the dorsal cortex and medullary cavity, together with its typical trajectory, aids the veterinary practitioner in distinguishing an NF from a pathologic fissure or fracture. Comparison with radiographs of the contralateral limb is unreliable as most NF are identified unilaterally.

Stifle radiography in Thoroughbreds from 6 to 18 months of age

Santschi *et al.* (2020)

The radiographic appearance of the stifle of young horse changes during the first 18 months of life but is not well described in Thoroughbreds. Our objective was to describe the radiographic appearance of the Thoroughbred stifle from 5 to 18 months of age and determine whether limiting exercise impacts the prevalence of radiographic abnormalities (RA). Bilateral stifle radiographs were obtained at a mean of 161 days of age in 141 subjects (set 1) and 347 days (set 2), and in 114 available subjects at 534 days (set 3), and graded for RA of the trochlear ridges (TR) and medial femoral condyle (MFC). The impact of exercise limits on RA was determined from a subgroup of subjects with set 1 RA that had 30–90 days limited exercise. Stifle RA were present in 50 subjects (35%) at set 1: 39 TR and 11 MFC. At set 2, 24 subjects (15.6%) had RA: 13 TR and 11 MFC. Set 1 RA had resolved in 36 (72%) subjects, persisted in 11 (22%) and changed location in 3. Ten of 91 (11%) subjects developed new RA at set 2. Twenty-seven subjects were unavailable for set 3 imaging, 6 with LTR RA at set 2. At set 3, 12/114 (11%) subjects had RA: 5 TR and 7 MFC. Set 2 RA resolved in 9 (50%) subjects, persisted in 8 (44%) and changed location in one. Three of 96 subjects developed new RA at set 3. Radiographic abnormality prevalence at set 3 was not different after limiting exercise. It was concluded that RA in the TR and MFC are common in 6-month-old Thoroughbreds and often resolve by 18 months. Radiographic abnormalities that develop later (~12 months of age) are less likely to resolve.

Magnetic resonance imaging of equine stifles: Technique and observations in 76 clinical cases

Waselau *et al.* (2020)

Magnetic resonance imaging (MRI) of equine stifle disorders is challenging. We describe a routine technique for low-field stifle MRI under general anaesthesia in clinical cases and report the main findings. We hypothesised that MRI can be safely and routinely performed and portray bone and soft tissue pathology. In this retrospective study, medical records of 76 stifles with positive response to intra-articular anaesthesia without abnormalities on conventional diagnostic imaging were reviewed for breed, age, sex, MRI anaesthesia time and findings. Under anaesthesia, limbs were

extended in a rotating MR gantry. Different sequences in several planes were acquired in an average time of 62 min. In all horses, the stifle examinations were successful and complete. Typical MRI lesions included bone marrow lesions, osseous cyst-like lesions, cruciate desmopathy, meniscal tearing or a combination thereof. Retrospective reviewing confirmed that initial radiographic and ultrasonographic images failed to identify these lesions. Surgically accessible lesions were confirmed in arthroscopy if exploration was indicated. However, MRI was useful to estimate extent of cruciate and meniscal pathology as well as bone marrow lesions and bone cystic-like lesions more thoroughly. Our protocol allows for routine stifle MRI, independent of breed, age and sex. Based on our preliminary results, low-field stifle MRI is safe and can delineate bone and soft-tissue pathology. Low-field MRI appears to be a promising approach for better understanding stifle pathology and thus treatment and prognosis.

Unexplained forelimb lameness possibly associated with radiculopathy

Dyson (2020)

There are limited descriptions of forelimb lameness that is not improved by diagnostic analgesia. The objectives of this retrospective study were to describe the clinical features, response to diagnostic analgesia and imaging findings in such horses (n = 25), to apply a ridden horse ethogram to video recordings of a subset of horses (n = 13) and to document post-mortem findings (n = 3). Clinical records from 2006 to 2016 were reviewed, and data concerning signalment, history, lame limb(s), lameness characteristics, response to diagnostic analgesia and diagnostic imaging were recorded. A ridden horse ethogram was applied to 13 horses to document pain-related behaviour. Results showed that nine horses had idiopathic hopping-type forelimb lameness only when ridden; two horses exhibited a hopping-type gait only on the lunge or worse on the lunge than ridden, and 14 horses had conventional lameness. Head and neck tilt was observed in 24% of horses. Lameness was different on a long rein compared with a contact in 28% of horses. Forelimb stumbling was a feature in 16% of horses. Exacerbation of lameness by diagnostic analgesia was seen in 76% of horses. Radiographic abnormalities of the caudal cervical and cranial thoracic vertebrae of potential clinical significance were observed in 92% of horses. Pain behaviour scores were higher than those reported for nonlame horses. Post-mortem examination of three horses provided the evidence of caudal cervical or cranial thoracic nerve root compression. Limitations of the study were that it cannot be assumed that there was a common aetiology of lameness in all horses. It was concluded that there is increasing evidence that nerve root injury may cause forelimb lameness.

Application of a ridden horse ethogram to video recordings of 21 horses before and after diagnostic analgesia: Reduction in behaviour scores

Dyson and Van Dijk (2020)

Identification of low-grade lameness is challenging. A whole horse ridden ethogram has been developed, describing 24 behavioural markers. Previous work indicated that the presence of ≥8 behavioural markers was likely to reflect musculoskeletal pain. The objectives of this repeated measures study were to compare the results of application of the ridden-horse ethogram by trained and untrained assessors to horses before and after musculoskeletal pain had been substantially improved using diagnostic analgesia, and to assess the repeatability of the ethogram application among untrained assessors, and to compare their performance with a trained assessor. All horses underwent a comprehensive lameness investigation. Anonymised video recordings of 21 lame horses, ridden by professional riders in trot and canter before and after diagnostic analgesia had abolished lameness, were reviewed in a random order by a trained assessor and 10 untrained assessors. For each horse, the duration of the recordings before and after diagnostic analgesia was time matched. The most frequent lameness grade was 2/8 (range 1–4). For the trained assessor, the number of behaviours exhibited by lame horses before diagnostic analgesia ranged from 3 to 12/24 (median 10; mean 8.9). After lameness and overall performance had been substantially improved using diagnostic analgesia, the number of behaviours ranged from 0 to 6/24 (median 3; mean 3.0). The decrease in behaviour scores for all assessors after diagnostic analgesia was highly significant ($Z = 20{,}147$, $P<0.0001$). Agreement between the trained assessor and untrained assessors was moderate before diagnostic analgesia and nonexistent after analgesia (Fleiss kappa 0.49, 0, respectively), when individual behaviours were assessed. The main limitation was that horses were anonymised, but it was impossible to blind their identity, so bias is possible. It was concluded that despite limitations in the agreement between untrained observers and the trained assessor, the ethogram is a potentially valuable tool for determining the presence of musculoskeletal pain and may be useful for longitudinal monitoring of improvement in lameness.

Can veterinarians reliably apply a whole horse ridden ethogram to differentiate nonlame and lame horses based on live horse assessment of behaviour?

Dyson *et al.* (2020)

A Ridden-Horse-Ethogram has been developed to differentiate between nonlame and lame horses, and lame horses before and after diagnostic analgesia have abolished musculoskeletal pain, based on video recordings. The objective of this prospective, observational study was to compare real-time application of the Ridden-Horse-Ethogram with analysis of video recordings of the horses by a trained assessor and to determine whether veterinarians, after preliminary training, could apply the ethogram in real time in a consistent way and in agreement with an experienced assessor. Ten equine veterinarians (after preliminary training) and an experienced assessor applied the ethogram to 20 horse-rider combinations performing a purpose-designed dressage test (8.5 min). The horses were a convenience sample, in regular work, and capable of working 'on the bit'. Video recordings of the test were analysed retrospectively by the experienced assessor. Lameness or abnormalities of canter, saddle fit, the presence of epaxial muscle tension/pain and rider skill level were determined by independent experts. The results were that 16 horses were lame; 11 had an ill-fitting saddle; and 14 had epaxial muscle tension/pain.

The expert determined total scores of 3-6/24 for the nonlame horses; two lame horses scored 3 and 6; and 14 lame horses scored 8–16. There was no significant difference in real-time scores and video-based scores for the experienced assessor. There was good agreement between the expert's scores and the mean test observer scores. There was excellent consistency in overall agreement among raters (intraclass correlation 0.97, P<0.001). There was a significant difference between ethogram scores according to lameness status for real-time (P = 0.017) and video (P = 0.013) observations by the experienced assessor and for the test observers' mean (P = 0.03). There was no effect of muscle pain, saddle fit or rider skill on behaviour. It was concluded that the ethogram was applied consistently by veterinarians with differentiation between nonlame and most lame horses. After appropriate training in its application, the ethogram may provide a useful tool for determining the presence of musculoskeletal pain in horses performing poorly.

Treatment of subchondral cystic lesions (SCLs) with parathyroid hormone peptide (PTH1-34)-enriched fibrin hydrogel in three different concentrations: A dose-blinded, randomised study

Jackson *et al.* (2020)

This study reports the use of parathyroid hormone fragment peptide 1-34 (PTH1-34) cross-linked to a hydrogel in a fibrin base for the treatment of subchondral cyst-like lesions (SCLs). The objectives were to determine the clinical and radiographic outcome of 28 horses with lameness attributable to one or two SCLs treated locally with one of three different concentrations of PTH1-34 and to identify which concentration produces the best results. Twenty-eight horses (34 SCLs) were treated surgically by debriding the content of the SCL and injecting different concentrations (0.1, 0.4 or 1 mg/mL) of PTH1-34 in a fibrin hydrogel into the cavity. Treatment was considered successful if the horse was sound 12 months after treatment. The mean age of the horses was 7.2 years. Treatment was successful in 22 (78.6%) horses and improved the radiographic appearance of 27 (79.4%) SCLs. The outcome was not affected by age of the horse or by the number of SCLs (1 or 2) per horse. PTH1-34 in a fibrin hydrogel administered into the SCL after surgical debridement of the lesion appears to be an effective treatment for horses with one or two SCLs. A PTH1-34 concentration of 0.4 mg/mL may be slightly superior to concentrations of 0.1 and 1.0 mg/mL in resolving SCLs.

Long-term outcome of 84 horses with sacroiliac joint region pain with (n = 69) or without (n = 15) other orthopaedic problems

Nagy *et al.* (2020)

The objective of this study was to establish the long-term outcome of horses with sacroiliac joint region pain alone and those with sacroiliac joint region pain in association with other problems that were managed conservatively. Horses diagnosed with sacroiliac joint region pain using diagnostic analgesia, with or without other concurrent orthopaedic problems, between January 2010 and December 2015 were identified. Only those horses managed conservatively were included in the study. Clinical data were obtained from the horses' files. Information on outcome and on the immediate rehabilitation following diagnosis was obtained from the owner or rider via a standardised telephone questionnaire. Descriptive statistics were performed and a chi-squared test was used to assess association between the outcome and variables on signalment, clinical parameters and variables related to rehabilitation. One hundred and seventy-eight horses were identified as cases; the questionnaire was completed for 84 horses (47.2% response rate). Fourteen horses (16.7%) returned to full work (mean follow-up: 233.4 weeks). Ten horses (11.9%) were still working at this level at the time of the telephone questionnaire, and one horse deteriorated after 2 years and three within 9 months. Twenty-seven horses (32.1%) returned to a lower level of work. Twenty-nine horses (34.5%) were retired and 14 (16.7%) were subjected to euthanasia shortly after the diagnosis. The outcome was significantly associated with the estimated magnitude of contribution of SI joint region pain to the horse's problem (P = 0.03). No horses with sacroiliac joint region pain alone returned to their previous level of work. Chronic sacroiliac joint region pain, either alone or in combination with other orthopaedic conditions, carries a poor prognosis for returning to full athletic function and a guarded prognosis for returning to some form of athletic activity at a lower level.

Ultrasonographic features associated with the lumbosacral or lumbar 5–6 symphyses in 64 horses with lumbosacral-sacroiliac joint region pain (2012–2018)

Boado *et al.* (2020)

The ultrasonographic appearance of the lumbosacral symphysis of horses with no history of hindlimb lameness or thoracolumbosacral pain has previously been documented. The aims of the study were to describe the signalment and clinical findings in horses with ultrasonographic lesions of the fifth and sixth lumbar (L) vertebrae and lumbosacral symphyses and to determine whether lesions of the L5-6 symphysis are only seen in horses with congenital sacralisation or other abnormalities of the lumbosacral symphysis. Horses in Group 1 (n = 25) underwent poor performance investigation and improved in ridden performance after infiltration of mepivacaine around the sacroiliac joints. Horses in Group 2 (n = 39) presented for investigation of changes in thoracolumbosacral shape or poor performance but did not undergo anaesthesia of the sacroiliac joint regions. The median ages were 10 and 19 years, respectively, for Groups 1 and 2. Mares (53.1%) were over-represented relative to the normal populations of the clinics. All horses had poor development of the thoracolumbar epaxial and pelvic muscles and prominence of the lumbar spinous processes and the tubera sacrale. Most horses (70%) had reduced range of movement of the thoracolumbosacral region. Ultrasonographic features included irregular vertebral end plates; heterogeneous echogenicity of the intervertebral disc ± ventral protrusion; and displacement of the ventral longitudinal ligament ± alteration in its echogenicity. In Group 1, abnormalities of the L5-6 symphysis were seen in 13 horses, of which 84.6% had congenital sacralisation or narrowing of the lumbosacral symphysis. In Group 2, the majority of horses had lesions of both the L5-6 and lumbosacral symphyses; only 9/39 horses (23.1%) had

congenital fusion of either joint. Limitations include the lack of age-matched control horses. However, the purpose of the study was to raise awareness of lesions of the L5-6 and lumbosacral symphyses, which may contribute to pain and poor performance.

Recumbency following diagnostic analgesia of the sacroiliac joint regions: 15 horses

Nagy and Dyson (2020)

Sacroiliac (SI) joint region pain is relatively common in sports horses, and diagnosis is ideally confirmed by diagnostic analgesia (SI joint region blocks). Anecdotal reports describe complications following SI joint region blocks, but there is no detailed published information. Our aim was to document a series of horses that became recumbent following SI joint region blocks. Clinicians were asked to participate via the e-mail list of the American College of Veterinary Sports Medicine and Rehabilitation and by contacting clinicians known to the authors to investigate poor performance and lameness in sports horses. Horses (n = 15) were included if they became recumbent following SI joint region blocks, with or without using other substances in addition to local anaesthetic solution. Data on the clinicians' experience, injection technique, clinical findings before and while the horse was recumbent and the outcome were collected in an online questionnaire. The clinicians' experience and injection techniques varied. In three horses' corticosteroids, with or without pitcher plant extract, were also injected with the local anaesthetic solution. In 14 horses, the injection(s) were performed at a clinic or hospital; 13 horses were injected in stocks. Seven horses were sedated for the procedure. Fourteen horses became recumbent within 10 min and one within 20 min. While recumbent, seven horses were sedated and six anaesthetised. Fourteen horses stood up at a mean time of 3.8 h after becoming recumbent; additional information was available for 13 horses, all of which made a complete recovery. Three horses suffered temporary complications (pneumonia related to intubation, abrasions from a sling and radial nerve dysfunction associated with slinging). One horse was subjected to euthanasia after 3 days because of failure to regain hindlimb function. In conclusion, recumbency following diagnostic analgesia of the SI joint regions can occur, but in the majority of horses, it has no long-term consequences.

The effects of rider size and saddle fit for horse and rider on forces and pressure distribution under saddles: A pilot study

Roost *et al.* (2020)

There is limited scientific evidence concerning the effect of rider weight on pressures under the saddle and equine performance. The objective of this prospective, crossover, randomised trial was to assess pressure distribution and magnitude in horses ridden by four riders of similar ability but differing in bodyweight and height. Six horses in regular work were ridden by four riders (rider bodyweight: horse body weight percentage >10 ≤12 [L = Light], >12 ≤15 [M = Moderate], >15 ≤18 [H = Heavy] and >20 [VH = Very Heavy]), performing a purpose-designed dressage test (30 min). The test was abandoned for ≥grade 3/8 lameness or ≥10 behavioural markers (assessed in real-time). A calibrated force mat (pliance) was used to record pressures under the saddle in walk, trot and canter on left and right reins. Rider position was assessed. All 13 H and VH tests and one of 12 M rider tests were abandoned (lameness, n = 12; behaviour, n = 1). At walk, the seat of rider VH extended beyond the cantle of the saddle; rider H sat on the cantle of the saddle. At trot and canter, the heels of rider VH were consistently cranial to the tubera coxae and shoulders. Pressures were significantly higher under the caudal aspect of the saddle compared with cranially for rider VH in walk ($P<0.05$, ANOVA, Bonferroni). At rising trot, pressures were higher cranially for riders L, M and H ($P<0.05$, ANOVA, Bonferroni), but were similar cranially and caudally for rider VH. The highest maximum peak pressure was recorded for rider VH in canter. A limitation was that speed can alter pressure measurements, but was not controlled or recorded. We concluded that there were differences in magnitude and distribution of pressures among the four riders according to their size, which may have contributed to the development of musculoskeletal pain. This may also have been influenced by saddle fit for riders and their positions.

Evaluating the suitability of an English saddle for a horse and rider combination

Bondi *et al.* (2020)

Correct saddle-fit for horse and rider is crucial for optimal comfort and performance. Poor saddle-fit is a frequent contributor to suboptimal performance but is often overlooked. The most common problems are incorrect tree width, the saddle positioned too close to the scapulae thus compromising forelimb movement, a pommel with inadequate clearance at the withers or a gullet which is effectively made too small by excessive padding under the saddle. The saddle provides the interface between the rider and the horse's thoracolumbar region. A rider that is too large for the saddle, out of balance or crooked will result in uneven force distribution under the saddle. Thus, rider position and stability in the saddle are also of vital importance for optimal performance. The assessment of saddle-fit for horse and rider is considered an integral part of poor performance evaluation.

An investigation into the occurrence of, and risk factors for, concurrent suspensory ligament injuries in horses with hindlimb proximal suspensory desmopathy

Gruyaert *et al.* (2020)

Hindlimb proximal suspensory desmopathy (PSD) is a common cause of lameness or poor performance in horses and may occur alone or together with other suspensory ligament (SL) injuries in forelimbs or hindlimbs. The aims of this retrospective case-control study (January 2009 to December 2018) were to describe the occurrence of, and identify risk factors for, concurrent SL injuries in horses with hindlimb PSD. Data concerning age, breed, sex, work discipline, height, bodyweight and work history were collected. Concurrent SL injuries were defined as forelimb proximal suspensory desmitis or SL branch injuries (≥grade 2 [0–3]) in any limb. Hindlimb PSD was graded mild, moderate or severe based on ultrasonography. Data were described, and multivariable logistic regression modelling was used to identify factors

associated with concurrent SL injuries. Data were available for 923 horses with hindlimb PSD, 28.6% (n = 264) of which had concurrent SL injuries. Age category (≤5 years of age vs. ≥6 years of age; P = 0.008), bodyweight:height ratio (P = 0.001), breed (P = 0.05), symmetry vs. asymmetry of hindlimb PSD ultrasonography grade (P = 0.005) and asymmetry vs. symmetry of lameness grade (P = 0.02) were associated with concurrent SL injury in horses with hindlimb PSD. Compared with horses aged ≥6 years, younger horses (odds ratio [OR] 1.76; 95% confidence interval [CI] 1.2–2.7) were more likely to have concurrent SL injury. The risk for concurrent SL injuries increased for every unit increase in bodyweight:height ratio (OR 2.27; CI 1.4–3.7). Compared with Thoroughbred crosses, Warmblood crosses (OR 3.3, CI 1.4–7.8), Thoroughbreds (OR 2.9, CI 1.1–7.1) and Irish Draught Horses (OR 3.5, CI 1.3–9.9) were more likely to have concurrent SL injuries. Hindlimb PSD ultrasonography grade severity was not associated with concurrent SL injury. In conclusion, age, bodyweight:height ratio and breed influenced the risk for concurrent lesions of the SL ligament. Further prospective studies in young horses are warranted.

An investigation of the association between hindlimb conformation and suspensory desmopathy in sports horses

Routh *et al.* (2020)

Proximal suspensory desmopathy (PSD) is a common cause of hindlimb lameness in sports horses; anecdotally, there is an association with straight hock conformation. The objective of this prospective observational study is to describe hindlimb conformation in horses with and without bilateral PSD. Horses examined over one year with a definitive diagnosis for lameness (based on clinical assessment, response to diagnostic anaesthesia, radiography, ultrasonography ± MRI or scintigraphy) were included (n = 193). Markers were placed on predefined landmarks. Lateral photographs were acquired from the left and right sides with the horse standing squarely, using standardised techniques, with each metatarsus perpendicular to the ground, aligned to the tuber ischii marker. Before data acquisition, repeatability studies for marker placement, horse positioning and angle measurements were performed. The tarsal and metatarsophalangeal angles were measured using Image Measurement. Orthopaedic diagnosis, breed, work discipline, weight, height and age were recorded. Z-tests, Fisher's exact tests, chi-squared tests and multivariable logistic regression were used to determine the associations between diagnosis, tarsal angles and possible confounding variables. Mann–Whitney *U* tests were used to evaluate the relationship between metatarsophalangeal joint angle and suspensory ligament injury. Horses with PSD had larger tarsal angles than controls (P = 0.003). The proportions of Warmblood-type horses and dressage horses with PSD were different to those of other breeds and work disciplines (P = 0.001, 0.02 respectively). A final logistic regression model demonstrated a significant effect of mean tarsal angle on outcome when breed and weight-height product were accounted for. There was an 11% increase in the odds of PSD for every degree increase in tarsal angle (CI 1.006–1.223, P = 0.04). There was no association between suspensory ligament injury and metatarsophalangeal joint angle. Assessment of tarsal angles at prepurchase examinations and prior to surgical treatment of PSD may be advisable.

Cow hock: A normal tarsal conformation in donkeys (*Equus asinus*)

Abdelgalil *et al.* (2020)

Cow hock is a conformational deformity of the tarsal joint in which the points of hocks are close to median plane. It is a normal feature in cattle and camels while it is a definite abnormality in horses. In donkeys, cow hock has been reported in both clinically normal and lame animals. The aim of this study was to develop a new objective method to diagnose and grade cow-hocked donkeys and to test the hypothesis that cow hock is prevalent in donkeys and can be considered normal conformation. A prospective study was conducted on 50 adult Egyptian baladi donkeys free from musculoskeletal disease. Subjective and objective evaluation was performed including goniometric and radiographic assessment of tarsal joint angle in extended full-weightbearing and maximum flexion from which the range of motion was calculated. A new linear measurement was designed to compare the distance between tuber ischii, points of hock and distance between the points situated at mid-distance between medial and lateral heels. Forty-four donkeys (88%) were subjectively cow-hocked, and 46 donkeys (92%) were cow-hocked based on rear view linear measurements. Thirteen donkeys (28.3%) were diagnosed with mild cow-hock, 18 (39.1%) moderate cow-hock and 15 (32.6%) severe cow-hock. Thirty-three (71.74%) of cow-hocked donkeys expressed base wide, 11 (23.91%) base narrow and two (4.35%) normal distal limb conformation. No statistically significant differences were reported between right and left joint angles in both goniometric and radiographic measurements. Strong positive correlation was recorded between goniometric and radiographic angular measurements in extended, flexed and range of motion. Poor correlation was reported between the degree of cow hock and the extended tarsal joint angle in both right (r = 0.1) and left (r = 0.2) tarsal joint angles. The study concluded that cow hock may be a prevalent nonpathological conformation in Egyptian baladi donkeys.

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References

Abdelgalil, A.I., Hassan, E.A. and Torad, F.A. (2020) Cow hock: a normal tarsal conformation in donkeys (*Equus asinus*). *Equine Vet. Educ.* **32**, *Suppl.* **10**, 193-198.

Beasley, B., Selberg, K., Giguère, S. and Allen, K. (2020) Magnetic resonance imaging characterisation of lesions within the collateral ligaments of the distal interphalangeal joint – 28 cases. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 11-17.

Boado, A., Nagy, A. and Dyson, S. (2020) Ultrasonographic features associated with the lumbosacral or lumbar 5–6 symphyses in 64 horses with lumbosacral-sacroiliac joint region pain (2012–2018). *Equine Vet. Educ.* **32**, *Suppl.* **10**, 136-143.

Bondi, A., Norton, S., Pearman, L. and Dyson, S. (2020) Evaluating the suitability of an English saddle for a horse and rider combination. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 162-172.

Clements, P.E., Handel, I., McKane, S.A. and Coomer, R.P. (2020) An investigation into the association between plantar distal phalanx

angle and hindlimb lameness in a UK population of horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 52-59.

Dau, S.L., Azevedo, M.S., de La Corte, F.D., Brass, K.E., Ceni, F. and Cantareli, C. (2020) Management of chronic foot lameness with 2% ammonium chloride on the palmar digital nerves. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 31-36.

Diekstall, M., Rijkenhuizen, A.B.M. and Gudehus, T. (2020) Tenoscopic resection of the manica flexoria in 21 horses using a two-portal unilateral technique. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 66-71.

Dyson, S.J. (2020) Unexplained forelimb lameness possibly associated with radiculopathy. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 92-103.

Dyson, S. and Van Dijk, J. (2020) Application of a ridden horse ethogram to video recordings of 21 horses before and after diagnostic analgesia: reduction in behaviour scores. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 104-111.

Dyson, S., Thomson, K., Quiney, L., Bondi, A. and Ellis, A.D. (2020) Can veterinarians reliably apply a whole horse ridden ethogram to differentiate nonlame and lame horses based on live horse assessment of behaviour? *Equine Vet. Educ.* **32**, *Suppl.* **10**, 112-120.

Frietman, S., van Proosdij, R., ter Braake, F. and de Heer, N. (2020) A detailed radiographic description of the nutrient foramen of the dorsal cortex of the proximal phalanx in horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 72-77.

Gruyaert, M., Pollard, D. and Dyson, S.J. (2020) An investigation into the occurrence of, and risk factors for, concurrent suspensory ligament injuries in horses with hindlimb proximal suspensory desmopathy. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 173-182.

Heer, C., Fürst, A.E., Del Chicca, F. and Jackson, M.A. (2020) Comparison of 3D-assisted surgery and conservative methods for treatment of type III fractures of the distal phalanx in horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 42-51.

Jackson, M.A., Ohlerth, S., Brink, P., Simon, O., Kummer, M. and Fürst, A.E. (2020) Treatment of subchondral cystic lesions (SCLs) with parathyroid hormone peptide (PTH1-34)-enriched fibrin hydrogel in three different concentrations: a dose-blinded, randomised study. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 121-128.

McGlinchey, L., Robinson, P., Porter, B., Sidhu, A.B.S. and Rosanowski, S.M. (2020) Quarter cracks in Thoroughbred racehorses trained in Hong Kong over a 9-year period (2007–2015): incidence, clinical presentation, and future racing performance. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 18-24.

Mullard, J., Ireland, J. and Dyson, S. (2020) Radiographic assessment of the ratio of the hoof wall distal phalanx distance to palmar length of the distal phalanx in 415 front feet of 279 horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 2-10.

Nagy, A. and Dyson, S. (2020) Recumbency following diagnostic analgesia of the sacroiliac joint regions: 15 horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 144-150.

Nagy, A., Quiney, L. and Dyson, S. (2020) Long-term outcome of 84 horses with sacroiliac joint region pain with (n = 69) or without (n = 15) other orthopaedic problems. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 129-135.

Oosterlinck, M., Pille, F., Lubbers, C., Haspeslagh, M. and Martens, A. (2020) Guillotine versus pull-through technique for palmar digital neurectomy: a retrospective study on 40 horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 37-41.

Pezzanite, L., Bass, L., Kawcak, C., Goodrich, L. and Moorman, V. (2019) The relationship between sagittal hoof conformation and hindlimb lameness in the horse. *Equine Vet. J.* **51**, 464–469.

Roost, L., Ellis, A.D., Morris, C., Bondi, A., Gandy, E.A., Harris, P. and Dyson, S. (2020) The effects of rider size and saddle fit for horse and rider on forces and pressure distribution under saddles: A pilot study. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 151-156.

Routh, J., Strang, C., Gilligan, S. and Dyson, S. (2020) An investigation of the association between hindlimb conformation and suspensory desmopathy in sports horses. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 183-192.

Santschi, E.M., Prichard, M.A., Whitman, J.L., Batten, C.A., Strathman, T.A., Canada, N.C. and Morehead, J.P. (2020) Stifle radiography in Thoroughbreds from 6 to 18 months of age. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 78-84.

Shaw, D.J. and Rosanowski, S.M. (2020) Tropical joint syndrome: exostosis on the dorsal aspect of the proximal phalanx in racing Thoroughbreds in Asia. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 60-65.

Tivey, M.-E.L., Van Dijk, J. and Dyson, S. (2020) Extensive ossification of the ungular cartilages and other osseous abnormalities of the proximal and distal phalanges. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 25-30.

Waselau, M., McKnight, A. and Kasparek, A. (2020) Magnetic resonance imaging of equine stifles: technique and observations in 76 clinical cases. *Equine Vet. Educ.* **32**, *Suppl.* **10**, 85-91.

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Editorial

Routine equine physiotherapy

What is equine physiotherapy?

Physiotherapists work with the patient to help those affected by injury or illness through movement and exercise, manual therapy, electrotherapy, education and advice. As a science-based profession they take a holistic approach to health, helping patients manage pain and prevent disease (Chartered Society of Physiotherapy [CSP], 2017a). In the UK, training to become a Chartered Physiotherapist requires a 3-year undergraduate degree and to become a veterinary physiotherapist and category A member of the Association of Chartered Physiotherapists in Animal Therapy (ACPAT), a minimum of 2 years post graduate training at UK Higher Education level 7 (Masters degree) is required. The title 'Chartered Physiotherapist' is protected by law and can only be used by physiotherapists who are members of the Chartered Society of Physiotherapy. However in the UK, the term physiotherapist is not a protected title in relation to the treatment of animals, therefore currently 'physiotherapy' for horses can be provided by any member of the public regardless of their level of training. As a consequence a multitude of courses have been developed, with standards varying from minimal to those providing 'day 1 competencies' equivalent to human practice at completion. To ascertain the standard of training of an individual, it is recommended to refer to an independent voluntary register such as the Register of Animal Musculoskeletal Practitioners (RAMP).

Equine Physiotherapists work within the team of professionals supporting horses at both the national and international level of competition. In the nonelite equine population, physiotherapists are also commonly involved in the management of musculoskeletal injuries in partnership with veterinary team as well as advising owners on regular assessment and treatment schedules for their horses. Working with the direction of a veterinary surgeon on a client's horse fulfils the requirements of the Veterinary Act (1966) Exemptions order (2015) and whilst there may be a practical difference in the treatment by physiotherapy for injury or for maintenance, the physiotherapist should always work within the scope of this legal framework. Communication between the physiotherapist and veterinary surgeon is crucial to delivering the best possible care to the equine athlete.

Horses with diagnosed injuries are likely to benefit from a programme of physiotherapy at all stages of rehabilitation (Tabor 2015). However, unfortunately there is no evidence to support either the frequency of physiotherapy treatments or specific protocols for particular diagnoses. Evidence is emerging for the effectiveness of individual treatment approaches, for instance, the use of spinal manipulation to reduce epaxial muscle tone (Wakeling *et al.* 2006), to reduce epaxial muscle pain (Sullivan *et al.* 2008) and to increase spinal range of motion (Haussler *et al.* 2010). More recently, evidence that supports the use of physiotherapy exercises to develop the muscles that provide intervertebral stability to the spine, called dynamic mobilisation exercises, has been published (Stubbs *et al.* 2011; Tabor *et al.* 2012; de Oliveira *et al.* 2015). Anecdotal reports from owners reporting the improved outcomes after treatment are suggestive that, as in human sports medicine, teamwork between veterinary surgeons and physiotherapists ultimately can be a key to treatment selection and achieving rehabilitation goals.

Benefits of routine physiotherapy

Routine or maintenance physiotherapy has yet to be defined fully for the management of horses but translation from human rehabilitation would suggest the aims are to prevent objectively measurable deterioration in a patient's quality of life and or to optimise the patients' functional capacity (Flanagan and Green 2000). Examples of maintenance physiotherapy interventions range from ongoing muscle strengthening programmes in elderly human patients at risk of falls and pain management for osteoarthritis to the other end of the spectrum when assisting management of the elite athlete during competition. Continuing treatment using the above definition refers to ongoing conditions that by their nature will not be fully resolved with a course of physiotherapy. Therefore in the non-injured sport horse or those with more chronic pathology, such as osteoarthritis, there may be a case for the adoption of maintenance physiotherapy. For a horse in full work, demands on the musculoskeletal system may predispose the horse to minor tissue injury that left unchecked, could affect quality of life, welfare and performance capacity. Some veterinary surgeons are starting to advocate maintenance physiotherapy to manage conditions and prevent deterioration and ultimately promote the welfare of the horse. The importance of a good working relationship between the veterinary surgeon and physiotherapist, as well as the coach, performance analyst, farrier and saddler is critical to the success of this team approach to ongoing management of the sport horse.

Regular visits by a physiotherapist, under the direction of a veterinary surgeon, could be included in the veterinary practice's health plan for equine clients. A physiotherapist would likely be able to spend a considerable amount of time with the client and have very confident knowledge of the particular horse's normal behaviour, movement pattern and reaction to palpation. Assessment would be less geared towards previous history, as this would be known, but focused on assessing and reassessing key metrics of the health of the musculoskeletal system. Clinically reasoning the ongoing approach to the patient by monitoring and evaluating the outcomes of treatments, is crucial to physiotherapy practice as an evidence informed profession. Taking into account current workload and any recent changes to behaviour, observations of gait and function should be included in the assessment. Modern technology

can be used to record and measure movement patterns either in-hand, on the lunge or performing ridden functional tasks required within their chosen discipline. Whilst inter-rater reliability of gait analysis by eye is low, reliability of repeated assessment by a single (experienced) observer is higher (Fuller *et al.* 2006). Systems to objectively measure gait symmetry, for instance inertial measurement units, are becoming more affordable and practical and have become available for routine clinical use. A mild asymmetrical pelvic movement pattern may be present at each physiotherapy assessment, however, it is important to note that the threshold or the use of a threshold at which the asymmetry is considered lameness is under debate (Weeren *et al.* 2017). A subtle gait asymmetry, when monitored regularly, may be unchanging. However it may, on subsequent assessment, have become more apparent to the physiotherapist even if at this stage not felt by the rider. The presence of asymmetry would be an indication for the physiotherapist to speak to the veterinary surgeon so a decision can be made whether to further investigate or monitor this finding. This enables all parties to adhere to BEVA guidelines for working with musculoskeletal therapists, which state maintenance physiotherapy is appropriate so long as the therapist is sufficiently well trained to recognise when veterinary intervention is required.

Palpation assessment forms an essential element of the physiotherapy assessment procedure and is a core skill of a physiotherapist. With the advent of scoring systems for muscular assessment, this section of the examination can be made more objective than perhaps considered initially. Varcoe-Cocks *et al.* (2006) and Walker *et al.* (2016) have used objective grading of pain reaction and muscle tone within groups of horses with and without suspected back pain. The first study demonstrated changes in pain and muscle stiffness in horse with sacro-iliac dysfunction and that palpation scores were correlated with objective measures of mechanical nociceptive threshold and the grade of the dysfunction. The second study used an in depth composite grading system to score muscle in dressage horses and moderate to good agreement was found between scores of five assessors using this grading system on ten horses. Using standardised, validated outcome measures in clinical practice is an explicit requirement of the CSP's standards (CSP 2017b). Whilst muscle soreness can be as a result of training at loads pushing the threshold of muscular strength, certain patterns of pain in the tissues could be indicative of an underlying sub-clinical issue that could progress to compromise performance (Hesse and Verheyen 2010). If training soreness does occur, treatment approaches can be used to prevent mild tension becoming problematic and compensatory movement patterns being adopted by the horse. Therefore the physiotherapist, working closely with the veterinary surgeon, can help manage in effect not only welfare but performance of the horse.

As well as offering treatments such as manual treatment and electrotherapy, with their knowledge of muscular physiology and principles of cardiovascular, strength and neuromuscular proprioceptive training physiotherapists are also well placed to take part in the design of exercise training programmes for their clients (Crook *et al.* 2010; Clayton *et al.* 2011; Stubbs *et al.* 2011; Kopec *et al.* 2018). Structuring weekly training levels alongside their coach should be part of this process. Recording work levels and even calculating training loads can make this element of the assessment valuable if it prevents either under or over training, which can limit performance development and increase the risk of injury (Gabbett 2016; Castejon-Riber *et al.* 2017). A considerable benefit from working with a Chartered Physiotherapist is that they can manage the rider as part of the performance analysis and work with them to reduce any negative impact from their own musculoskeletal injury, weakness or imbalances.

How frequently maintenance visits occur would depend on the level of the competition horses were involved in and the individual characteristics of the horse, such as breed, age and discipline. If the horse is in a stage of training where upward progression of the level of work is expected then less time between assessments would be recommended. In this instance 3 to 6 weekly visits may be required. This is inline with both cardiovascular and hypertrophic muscle changes expected with a training programme with increasing demands (Rivero 2007). This is particularly relevant to the ridden horse in terms of changing thoracolumbar epaxial muscle size and subsequent saddle fit (Dyson and Greve 2016). However if the horse is at a lower performance/ competitive level and with little history of pre-existing conditions a visit every 6 months perhaps in the spring and autumn would suffice. Ultimately, visit frequency may be influenced by the financial circumstances of the clients therefore a physiotherapist would be working unethically if they suggested revisiting more frequently than would be based on sound clinical reasoning.

Recommendations

Adopting good practice from contemporary musculoskeletal injury management in human medicine is crucial to the development of physiotherapy for the equine athlete. Being able to select treatment choices based on good quality research is the ideal for the evidence based practitioner. Clinicians need to draw ideas together and discuss best practice with the consideration that evidence-based practice is not only about clinical trials but about the clinical experience and the patient (Djulbegovic and Guyatt 2017).

One major difficulty is that the process of evaluating effect is currently limited due to limited validated and reliable outcome measures, which are able to report on the success or failures of physiotherapy intervention beyond anecdote. Consideration to the knowledge and understanding of the owner/trainer/rider as well as their judgement and emotion surrounding the expectation of physiotherapy would also have to be taken into account to limit false reporting of outcome.

To support the increasing demands of equine clients to manage their horse's health and welfare, as well as supporting rehabilitation cases a close working relationship between the veterinary surgeon and physiotherapist can be recommended. Successful management of the performance horse requires input from a range of professionals, working as an inter-disciplinary team. This is ultimately beneficial to the horse.

Author's declaration of interests

No conflicts of interest have been declared.

Ethical animal research

As a clinical commentary there was no requirement for ethical review.

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References

Castejon-Riber, C., Riber, C., Rubio, M.D., Agüera, E. and Muñoz, A. (2017) Objectives, principles, and methods of strength training for horses. *J. Equine. Vet. Sci.* **56**, 93-103.

Chartered Society of Physiotherapy (2017a) *What is Physiotherapy?* Available from: http://www.csp.org.uk/your-health/what-physiotherapy

Chartered Society of Physiotherapy (2017b) *Outcome and Experience Measures*. Available from: http://www.csp.org.uk/professional-union/practice/evidence-base/outcome-measures-experience-measures

Clayton, H.M., Lavagnino, M., Kaiser, L.J. and Stubbs, N.C. (2011) Evaluation of biomechanical effects of four stimulation devices placed on the hind feet of trotting horses. *Am. J. Vet. Res.* **72**, 1489-1495.

Crook, T.C., Wilson, A. and Hodson-Tole, E. (2010) The effect of treadmill speed and gradient on equine hindlimb muscle activity. *Equine Vet. J.* **42**, *Suppl*. **38**, 412-416.

Djulbegovic, B. and Guyatt, G.H. (2017) Progress in evidence-based medicine: a quarter century on. *Lancet* **390**, 415-423.

Dyson, S. and Greve, L. (2016) Saddles and girths: what is new? *Vet. J.* **207**, 73-79.

Flanagan, T. and Green, S. (2000) The concept of maintenance physiotherapy. *Aust. J. Physiother.* **46**, 271-278.

Fuller, C.J., Bladon, B.M., Driver, A.J. and Barr, A.R. (2006) The intra-and inter-assessor reliability of measurement of functional outcome by lameness scoring in horses. *Vet. J.* **171**, 281-286.

Gabbett, T.J. (2016) The training-injury prevention paradox: should athletes be training smarter and harder? *Br. J. Sports Med.* **50**, 273-280.

Haussler, K.K., Martin, C.E. and Hill, A.E. (2010) Efficacy of spinal manipulation and mobilisation on trunk flexibility and stiffness in horses: a randomised clinical trial. *Equine Vet. J.* **42**, *Suppl*. **38**, 695-702.

Hesse, K.L. and Verheyen, K.L.P. (2010) Associations between physiotherapy findings and subsequent diagnosis of pelvic or hindlimb fracture in racing Thoroughbreds. *Equine Vet. J.* **42**, 234-239.

Kopec, N.L., Williams, J.M. and Tabor, G.F. (2018) Kinematic analysis of the thoracic limb of healthy dogs during descending stair and ramp exercises. *Am. J. Vet. Res.* **79**, 33-41.

de Oliveira, K., Soutello, R.V., da Fonseca, R., Costa, C., Paulo, R.D.L., Fachiolli, D.F. and Clayton, H.M. (2015) Gymnastic training and dynamic mobilization exercises improve stride quality and increase epaxial muscle size in therapy horses. *J. Equine. Vet. Sci.* **35**, 888-893.

Rivero, J.L. (2007) A scientific background for skeletal muscle conditioning in equine practice. *Transbound. Emerg. Dis.* **54**, 321-332.

Stubbs, N.C., Kaiser, L.J., Hauptman, J. and Clayton, H.M. (2011) Dynamic mobilisation exercises increase cross sectional area of musculus multifidus. *Equine Vet. J.* **43**, 522-529.

Sullivan, K.A., Hill, A.E. and Haussler, K.K. (2008) The effects of chiropractic, massage and phenylbutazone on spinal mechanical nociceptive thresholds in horses without clinical signs. *Equine Vet. J.* **40**, 14-20.

Tabor, G.F., Johansson, C. and Randle, H. (2012) The effects of dynamic mobilization exercises on the multifidus muscle in thoroughbred racehorses. In: *The Road Ahead, Proceedings 8th International Equitation Science Conference, Edinburgh, UK*. Eds: H. Randle, N. Waran, J. Williams. pp. 64. Available at: http://www.equitationscience.com/documents/Conferences/ISESConferenceProceedings2012.pdf.

Tabor, G. (2015) Physiotherapy management of the equine athlete. In: *Training for Equestrian Performance*. Eds: J. Williams, D. Evans. Wageningen Academic Publishers, Wageningen, pp. 325-342.

Varcoe-Cocks, K., Sagar, K.N., Jeffcott, L.B. and McGowan, C.M. (2006) Pressure algometry to quantify muscle pain in racehorses with suspected sacroiliac dysfunction. *Equine Vet. J.* **38**, 558-562.

Wakeling, J.M., Barnett, K., Price, S. and Nankervis, K. (2006) Effects of manipulative therapy on the longissimus dorsi in the equine back. *Equine Comp. Exerc. Physiol.* **3**, 153-160.

Walker, V.A., Tranquille, C.A., Dyson, S.J., Spear, J. and Murray, R.C. (2016) Association of a subjective muscle score with increased angles of flexion during sitting trot in dressage horses. *J. Equine. Vet. Sci.* **40**, 6-15.

Weeren, P.R., Pfau, T., Rhodin, M., Roepstorff, L., Serra Bragança, F. and Weishaupt, M.A. (2017) Do we have to redefine lameness in the era of quantitative gait analysis? *Equine Vet. J.* **49**, 567-569.

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Case Report

Surgical management of an enterocutaneous umbilical fistula caused by an incarcerated Richter's hernia in a one-year-old Quarter Horse filly

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Keywords: horse; Littré hernia; Richter's hernia; umbilical hernia; Heineke-Mikulicz technique; intestinal fistula

Summary

A one-year-old Quarter Horse filly was presented with a 6-day history of a wound located centrally in an umbilical swelling (20 × 20 × 10 cm) which was firm, warm and painful on palpation; the wound was leaking ingesta and suspected to be an enterocutaneous fistula (ECF). The filly did not show signs of colic. Clinical laboratory tests revealed hypoproteinaemia (47.6 g/L: reference range [RR] 57.7–72.9 g/L), hypoalbuminaemia (18.8 g/L: RR 24.4–35.6 g/L) and mild thrombocytopenia (0.17%: RR 0.18–0.43%). Ultrasonographically, an umbilical hernia was diagnosed containing a small intestinal loop which appeared to be adhered to the body wall around an ECF.

Surgical treatment was performed under general anaesthesia in dorsal recumbency. To avoid contamination of the surgical field, the opening of the fistula was cleaned and closed with a continuous Lembert suture and an adhesive drape. A fusiform skin incision was made around the hernial sac which was isolated from the abdominal wall in the subcutis (**Fig 1**). A short celiotomy craniolateral to the hernia ring allowed the manual identification of the incarcerated segment of the ileum adhering to the umbilical hernia ring on the antimesenteric aspect. A Richter's hernia was diagnosed and resected en bloc from the aponeurosis in a fusiform pattern. After separation using Doyen intestinal forceps, the adhering portion of the ileum was excised as close as possible to the adhesion. Closing the intestinal wall using a modified Heineke-Mikulicz technique for pyloroplasty (**Fig 2**) preserved the intestinal lumen, making a standard resection with end-to-end anastomosis unnecessary and thereby leaving the mesentery including its vessels intact. This reduced the potential risks of insufficiency of the intestinal wall closure and stricture formation. The abdominal wall was closed in three layers with the linea alba being closed with a simple continuous pattern and additional vertical mattress sutures. Seven days after surgery, a partial suture dehiscence of the intracutaneous suture occurred, which was treated locally twice daily over 17 days by cleaning, topical application of povidone iodine and an abdominal bandage. Twenty-four days after surgery, the wound was completely closed and the filly was discharged. One year after surgery, the filly had developed normally without any long-term complications.

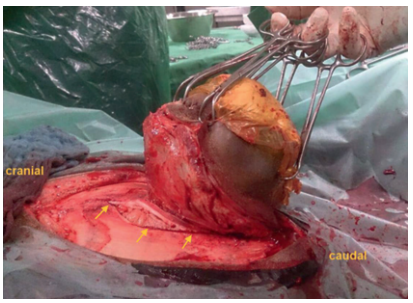

Fig 1: En bloc resection of an umbilical hernia including an enterocutaneous fistula from the ventral abdominal wall. An incision of the linea alba has been made close to the hernia ring (arrows).

Fig 2: Closure of the ileal wall with a single layer continuous Lembert suture transverse to the long axis of the intestine (modified Heineke-Mikulicz technique) after placing opposing stay sutures bisecting the longitudinal extension of the wound margins.

Key points

- Enterocutaneous fistulae may develop after Richter's hernia without signs of abdominal discomfort.
- En bloc resection of an enterocutaneous fistula close to the intact ileal wall resulted in an antimesenteric elliptical intestinal wall defect of limited size.
- Closure of the intestinal wall transversely to the long axis of the intestinal wall (i.e. with a modified Heineke-Mikulicz technique) is a less invasive lumen preserving alternative to a standard end-to-end anastomosis and led to an excellent outcome.

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Case Report

Tenoscopic removal of a protruding osteophyte as a treatment for chronic common digital extensor tendinopathy and associated tenosynovitis

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Keywords: horse; common digital extensor tendon sheath; tenoscopic debridement; chronic tenosynovitis; osteophyte

Summary

A 12-year-old Quarter Horse gelding was referred for evaluation of the right common digital extensor tendon sheath due to a suspected chronic tenosynovitis of 5 months' duration. On presentation, the gelding exhibited a grade 3/5 right forelimb lameness, which did not increase when the carpus was flexed. On physical examination, there was marked effusion of the right common digital extensor tendon sheath.

Digital radiography of the right carpus revealed an osteophyte protruding from the proximal aspect of the third metacarpal bone at the dorsolateral aspect of the carpometacarpal joint (**Fig 1**). Ultrasonographic examination of the right carpus confirmed the presence of an increased volume of anechoic fluid within the common digital extensor tendon sheath; however, no abnormalities of the tendon itself were detected. Based on these findings, tenoscopic evaluation of the right common digital extensor tendon sheath was recommended and performed the next day.

Tenoscopic exploration of the tendon sheath identified the presumed osteophyte. As the limb was flexed, the osteophyte came into contact with the common digital extensor tendon and the tendon had frayed fibres present (**Fig 2**). The osteophyte was removed and the tendon was debrided.

The gelding recovered from anaesthesia uneventfully and was discharged the same day as surgery with instructions to give phenylbutazone for 7 days and to remain on stall rest in a bandage for 14 days.

Four weeks post-operatively the gelding presented for re-evaluation. At that time, the tendon sheath was medicated with triamcinolone acetonide, amikacin, and hyaluronate sodium due to slight residual effusion of the common digital extensor tendon sheath.

Follow-up information was obtained by telephone conversation with the owner 8 months post-operatively. The gelding had returned to his previous level of activity and the owners had noted no further effusion of the common digital extensor tendon sheath.

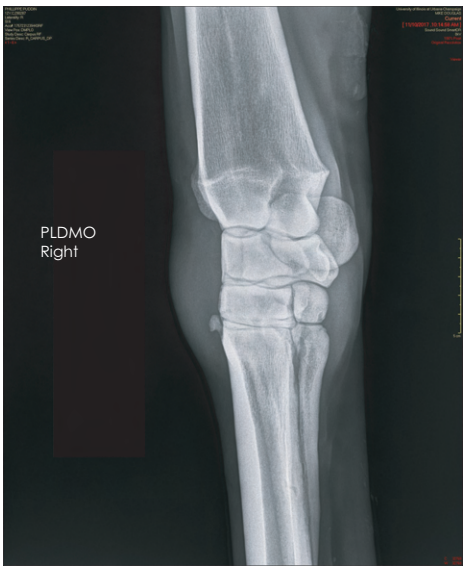

***Fig 1:** Palmaro-lateral to dorso-medial oblique radiograph of the right carpus showing a large osteophyte at the dorsolateral aspect of the carpometacarpal joint, as well as moderate to marked soft tissue swelling on the dorsal aspect of the carpus.*

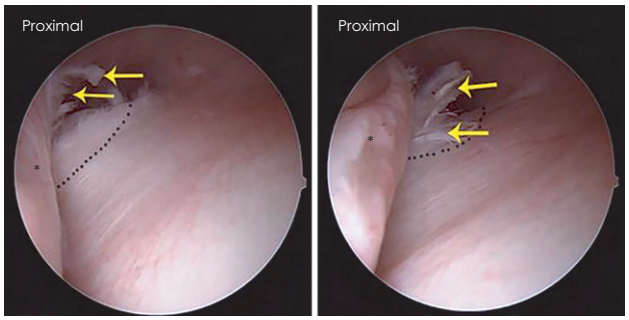

***Fig 2:** Tenoscopic appearance of the common digital extensor tendon (asterisk) as it moves through flexion showing contact with the osteophyte (dotted line) and frayed tendon fibres (arrows).*

Key points

- Osteophytes of the carpometacarpal joint can be a source of focal traumatic tendonitis of the common digital extensor tendon which can lead to a chronic tenosynovitis of the common digital extensor tendon sheath.
- Tenoscopic evaluation can be an important diagnostic tool for cases in which ultrasonographic evaluation is inconclusive.
- Tenoscopic debridement and lavage is a viable treatment option for chronic nonseptic common digital extensor tendinopathy and associated tenosynovitis.

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Case Report

Tenoscopic-assisted treatment of a solitary caudodistal tibial osteochondroma

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Keywords: horse; osteochondroma tarsal sheath tenoscopy

Summary

A 3-year-old polo pony mare presented for evaluation of acute onset severe left hindlimb lameness with marked tarsal sheath effusion of 3 weeks' duration. Radiography and ultrasonography revealed the presence of an osseous protrusion from the caudal distal tibia, deemed likely to be a solitary osteochondroma, penetrating the fibres of the lateral digital flexor tendon (LDFT) within the tarsal sheath and resulting in tenosynovitis (**Figs 1** and **2**). Surgical treatment was performed, commencing with tarsal sheath tenoscopy using a standard arthroscopic portal 2 cm proximal to the sustentaculum tali and plantar to the LDFT (Cauvin *et al*. 1999) and an instrument portal placed in the proximal recess under arthroscopic guidance. Evaluation of the sheath plantar to the mesotendon of the LDFT revealed linear disruption to the plantar surface of the tendon with marked prolapse of fibres and surface fibrillation. The caudal-most point of the suspected osteochondroma could be seen passing through the entire LDFT and exiting the plantar surface of the tendon. The exposed and damaged tendon fibres were debrided with a motorised synovial resector. An open surgical technique was employed to facilitate complete surgical removal of the osteochondroma. A 4-cm vertical skin incision was created overlying the osteochondroma on the caudal aspect of the tibia and an osteotome and mallet were used to detach it from the tibial metaphysis, with radiographic confirmation of complete removal. The surgical site was closed in two layers (simple continuous 3 metric polyglactin 910 [Vicryl]) in the subcutaneous tissue and cruciate mattress sutures of 3 metric polyamide (Ethilon) in the skin and the arthroscopic portals closed with 3 metric polyamide in a cruciate mattress pattern. Histopathological analysis confirmed the lesion to be an osteochondroma. The horse recovered well post-operatively and repeat examination three months following surgery revealed the horse to be sound at the walk and trot with minimal tarsal sheath effusion.

This case reports the first use of tarsal sheath tenoscopy and debridement of LDFT pathology as an adjunctive treatment for caudal distal tibial osteochondroma. Although a rare diagnosis, tenoscopy should be considered in similar future cases and likely contributed favourably to the outcome in this case.

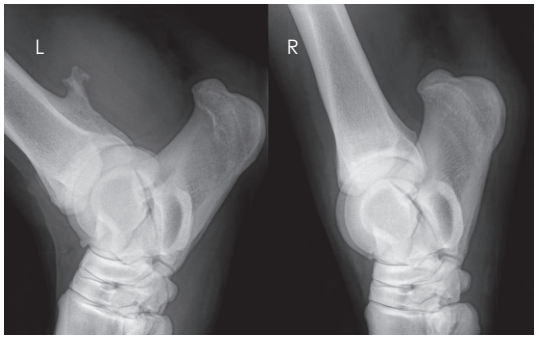

Fig 1: Lateromedial radiographs of the left and right tarsi, demonstrating a bony exostosis just proximal to the left distal tibial physis.

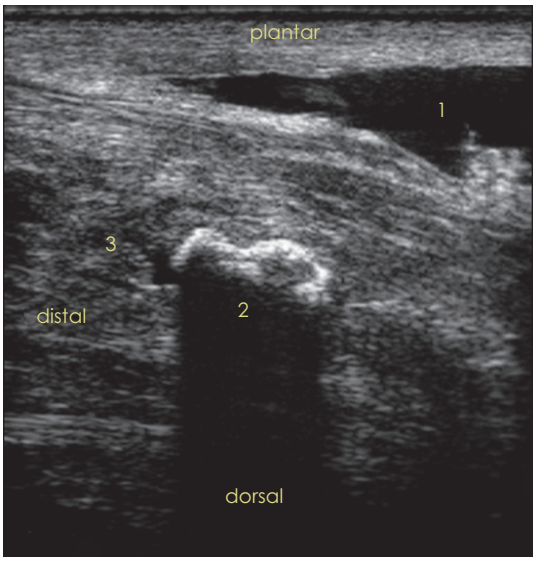

Fig 2: Ultrasonographic image of the left tarsal sheath demonstrating pathology affecting the lateral digital flexor tendon (LDFT). 1: effusion within the tarsal sheath. 2: bony exostosis. 3: disrupted fibres of the LDFT.

Key points

- Solitary osteochondromas of the distal tibia are an infrequent cause of lameness in the horse, but should be considered in cases with significant tarsal sheath effusion.
- Tenoscopic evaluation of the tarsal sheath facilitated evaluation and tenoscopic debridement of the damaged and prolapsed fibres of the lateral digital flexor tendon (LDFT).
- Open and minimally invasive surgical techniques were combined in this case to achieve a good post-operative outcome, with the horse returning to previous exercise levels.

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Clinical Commentary

What is an osteochondroma?

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The case report by Agass and Fraser in this issue (2020) describes the diagnosis and successful surgical treatment of an osteochondroma in a 3-year-old Polo pony mare. The unusual features of this case include the uncommon location of the osteochondroma within the caudal distal metaphysis of the tibia and the requirement of an extrathecal approach to enable its removal. Location and surgical approach withstanding, this case shows a number of similarities with cases of the more commonly identified radial osteochondromas. This clinical commentary takes an in depth look into the aetiology and pathogenesis of this condition in order to help explain the features of this case.

An osteochondroma is a bony outgrowth from the metaphysis or extremity of the diaphysis and represents an aberration of endochondral ossification. It most commonly occurs in long bones but can occur in any bone where growth occurs by endochondral ossification. Osteochondromas are the most common benign bony growth identified in man (Saglik *et al.* 2006). They are infrequently reported in horses and have been identified in other species including the dog and the rat (Ernst *et al.* 1992; Green *et al.* 1999). In man, they are commonly described as benign bone tumours but more recent literature suggests they should be classed as developmental lesions based on their pathogenesis (Murphey *et al.* 2000). Solitary osteochondromas have been produced experimentally by transplanting physeal tissue into cortical bone, supporting the following theory of their development (D'Ambrosia and Ferguson 1968; Delgado *et al.* 1987).

An osteochondroma is derived from a portion of aberrant cartilaginous tissue which proliferates and separates from the edge of an epiphyseal growth plate during bone growth. This tissue separation is thought to occur secondary to osteoclastic activity in the periosteum of the metaphysis, which serves to reduce the outer diameter of the metaphysis and remodel it into the narrower diaphysis as the bone elongates (Jerome *et al.* 2017). The displaced tissue remains in a periosteal location and continues to grow autonomously. It subsequently either disappears through remodelling or herniates through the cuff of periosteal bone which surrounds the growth plate, where it continues to grow and mature by endochondral ossification. The result is an osseous protuberance with a cartilage cap, which is located close to and projects at right angles to the growth plate from which it originated. A defining feature of an osteochondroma is that the bony protuberance is continuous with the underlying cortex and in some cases, the medullary canal (Milgram 1983; Resnick *et al.* 1995).

In man, an osteochondroma enlarges only during skeletal growth but can continue to ossify after skeletal maturity (Biermann 2002). The cartilage cap therefore decreases in thickness with increasing age of the subject, being completely absent in some older individuals. A disproportionately thick cartilage cap in mature adults is associated with malignant transformation to a chondrosarcoma, an important potential sequela (Murphey *et al.* 2000). Histopathological findings in the case reported by Agass and Fraser (2020) were typical of an osteochondroma in that the tissue was covered in a smooth layer of cartilage, with evidence of endochondral ossification.

An osteochondroma usually presents as a solitary lesion but bilateral cases have been reported in horses (Wright and Minshall 2012). Multiple lesions are seen in the condition called hereditary multiple exostosis (HME) which is a rare autosomal dominant genetic disorder. HME has been reported in one stallion and its progeny in North America (Gardner *et al.* 1975; Shupe *et al.* 1979, 1981), in one case in Australia (Wilson *et al.* 1985) and with scant additional mention in older literature. HME occurs with an incidence of approximately 1/50,000 in man (Wuyts *et al.* 1998).

An important differential diagnosis of an equine distal radial osteochondroma is an exostosis of the distal radial physis. This bony growth is differentiated by its location at the physeal scar, rather than proximal to it (Zetterström *et al.* 2017). To my knowledge, exostoses of the distal tibial physes have not been described. Although osteochondromas are usually surgically accessible via the synovial lined tendon sheath into which they protrude, they originate in an extrasynovial location and when examined tenoscopically are observed to be overlaid by, or protrude through, the synovium (Secombe and Anderson 2000; Wright and Minshall 2012). This may explain why the base of the large osteochondroma treated by Agass and Fraser (2020) was more readily accessed by an extrathecal approach. I have encountered one case of an osteochondroma located in an entirely extrathecal location on the caudolateral aspect of the distal metaphysis of the radius. A 9-year-old Thoroughbred mare presented with lameness and a painful swelling over a small, firm, palpable protuberance. Radiographs revealed an osteochondroma 8 mm in length, located 12 mm proximal to the distal physeal scar (**Fig 1**). Standing surgical excision was curative.

The physical characteristics of equine distal radial osteochondromas have been described in detail by Wright and Minshall (2012), based on their diagnostic imaging features and tenoscopic appearance within the carpal sheath. The authors described 25 radial osteochondromas and found them located 7 to 33 mm proximal to the distal metaphyseal growth plate and measuring 3 to 29 mm in length. All lesions protruded approximately perpendicular to the radius, with most inclining proximally. The tendency for osteochondromas to point away from the nearest joint is also noted in the human literature, thought to be due to the forces exerted by overlying soft tissues (Murphey *et al.* 2000). All osteochondromas protruded into the carpal sheath, with all but three lesions causing disruption of the overlying deep digital flexor tendon. Lack of impingement on the tendon was associated with a more lateral location of the

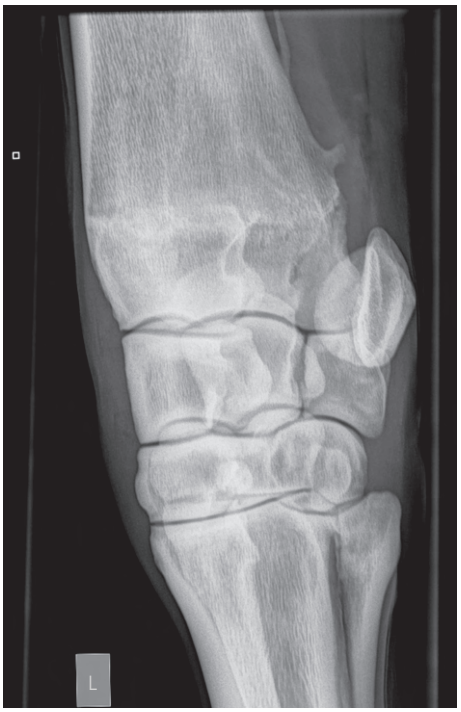

Fig 1: Dorsolateral palmaromedial oblique radiographic projection of the left carpus of a 9-year-old Thoroughbred with a small osteochondroma on the caudolateral aspect of the distal radius. This lesion did not protrude into the carpal sheath.

osteochondroma on the caudal radius (Wright and Minshall 2012).

In contrast to the horse, osteochondromas are commonly found at numerous anatomical sites in man. Radiographic findings are usually considered diagnostic, with consistent correlation between radiographic and histopathological findings. Computed tomographic imaging is considered helpful for imaging osteochondromas in locations of complex anatomy; however, ultrasound has been shown to be more accurate for imaging the thickness of a nonmineralised cartilage cap (Murphey *et al.* 2000). Human males are more frequently affected than females with a ratio of approximately 1.5:1, for reasons undefined (Saglik *et al.* 2006; Florez *et al.* 2008). Breed or gender predisposition has not been described in horses; however, males may be over represented, comprising 17 of 22 cases in Wright and Minshall's case series (2012). Humans most commonly present with the condition at around 21 years, with a wide age range of presentation between 6 and 77 years (Saglik *et al.* 2006; Florez *et al.* 2008). The equine presentation at 3 years old, as in the accompanying case report, would appear typical for equine cases. Mean age at presentation was 2.8 years in Wright and Minshall's population of primarily racing Thoroughbreds and in a series of four affected Warmbloods, affected horses were 3–5 years of age (Braake and Rijkenhuizen 2001). Osteochondromas can appear very early in life, with two cases reported in foals (Chan *et al.* 1996; Easter *et al.* 1998). It is unknown whether timing of clinical presentation in horses reflects the time that an osteochondroma appears, the timing of its ossification or the occurrence of physical irritation of overlying tissues with the onset of work.

Human patients present with pain in less than 50% of cases. Pain is usually related to the mass effect of the growth, namely soft tissue disturbance, bursa formation or impingement on joint mobility. Solitary osteochondroma are always benign growths; however, malignant transformation to chondrosarcoma is the most significant secondary concern, occurring in 2.2% of cases in one study (Saglik *et al.* 2006). Neoplastic transformation has been reported in dogs (Green *et al.* 1999) but to my knowledge has not been reported in horses.

Equine cases have a consistent pattern of presentation due to the more consistent lesion location. Most cases protrude into a tendon sheath, including the carpal sheath (Braake and Rijkenhuizen 2001; Wright and Minshall 2012), the tarsal sheath (Secombe and Anderson 2000; Agass and Fraser 2020) and the sheath of the extensor carpi radialis tendon (Russell *et al.* 2017). Common presenting features are effusion of the affected synovial sheath and in most cases lameness. Lameness can be of varying severity and is attributed to synovial distension and to physical disruption of an overlying tendon within the sheath.

Tenoscopic resection of an osteochondroma and debridement of the disrupted tendon carries an excellent prognosis for return to full athletic function. All 22 horses in Wright and Minshall's case series returned to work, with horses returning to racing at a mean time of 6 months post surgery. Four horses reported by Braake and Rijkenhuizen (2001) were sound in trot at 6 weeks post surgery and all returned to full work. The two reported cases of tibial osteochondroma within the tarsal sheath had an equally positive outcome with similar treatment, with both cases returning to full work. The rapid resolution of lameness led to speculation by Braake and Rijkenhuizen (2001) that lameness may be secondary to tenosynovitis rather than tendon injury, since the tendon might be expected to take longer to heal. Ultrasound monitoring of the affected tendon after surgery may help to evaluate the healing process but can be difficult to justify if the horse is sound. The excellent prognosis justifies surgical treatment and tenoscopy is always indicated, whether the osteochondroma is resected via an intrathecal or extrathecal approach. Performing histopathology on resected tissue is less important than in man since removal is curative and malignant transformation has not been reported.

Author's declaration of interests

No conflicts of interest have been declared.

Ethical animal research

Not applicable.

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References

Agass, R. and Fraser, B. (2020) Tenoscopic-assisted treatment of a solitary caudodistal tibial osteochondroma. *Equine Vet. Educ.* **32**, 354.

Biermann, J.S. (2002) Common benign lesions of bone in children and adolescents. *J. Pediatr. Orthop.* **22**, 268-273.

Braake, F. and Rijkenhuizen, A.B.M. (2001) Endoscopic removal of osteochondroma at the caudodistal aspect of the radius: an evaluation in 4 cases. *Equine Vet. Educ.* **13**, 90-93.

Chan, C.C.-H., Munroe, G.A. and Callanan, J.J. (1996) Congenital solitary osteochondroma affecting the tarsus in a filly foal. *Equine Vet. Educ.* **8**, 153-156.

D'Ambrosia, R. and Ferguson, A.B. Jr (1968) The formation of osteochondroma by epiphyseal cartilage transplantation. *Clin. Orthop. Relat. Res.* **61**, 103-115.

Delgado, E., Rodriguez, J.L., Miralles, C. and Paniagua, R. (1987) Osteochondroma induced by reflection of the perichondrial ring in young rat radii. *Calcif. Tissue Int.* **40**, 85-90.

Easter, J.L., Watkins, J.P., Berrige, B. and Homco, L.D. (1998) A digital osteochondroma as the cause of lameness in a foal. *Vet. Comp. Orthop. Traumatol.* **11**, 49-51.

Ernst, H., Sander, E., Karbe, E., Nolte, T. and Mohr, U. (1992) Osteochondroma in laboratory rats: a report of 3 cases in a Fischer-344, a Sprague-Dawley, and a Wistar Rat. *Toxicol. Pathol.* **20**, 264-267.

Florez, B., Monckeberg, J., Castillo, G. and Beguiristain, J. (2008) Solitary osteochondroma long-term follow-up. *J. Pediatr. Orthop.* **17**, 91-94.

Gardner, E.J., Shupe, J.L., Leone, N.C. and Olson, A.E. (1975) Hereditary multiple exostosis: a comparative genetic evaluation in man and horses. *J. Heredity* **66**, 318-322.

Green, E.M., Adams, W.M. and Steinberg, H. (1999) Malignant transformation of solitary spinal osteochondroma in two mature dogs. *Vet. Rad. Ultrasound* **40**, 634-637.

Jerome, C., Hoch, B. and Carlson, C.S. (2017) Skeletal system. In: *Comparative Anatomy and Histology: A Mouse, Rat and Human Atlas*, 2nd edn., Eds: P.M. Treuting, S.M. Dintzis and K.S. Montine, Elsevier, Amsterdam. pp 67-88.

Milgram, J.W. (1983) The origins of osteochondromas and enchondromas: a histopathologic study. *Clin. Orthop.* **174**, 264-284.

Murphey, M.D., Choi, J.J., Kransdorf, M.J., Flemming, D.J. and Gannon, F.H. (2000) Imaging of osteochondroma: variants and complications with radiologic-pathologic correlation. *Radiographics* **20**, 1407-1434.

Resnick, D., Kyriakos, M. and Greenway, G.D. (1995) Osteochondroma. In: *Diagnosis of Bone and Joint Disorders*, 3rd edn., Vol 5, Eds: D. Resnick, Saunders, Philadelphia. pp 3725-3746.

Russell, J.W., Hall, M.S. and Kelly, G.M. (2017) Osteochondroma on the cranial aspect of the distal radial metaphysis causing tenosynovitis of the extensor carpi radialis tendon sheath in a horse. *Aust. Vet. J.* **95**, 46-48.

Saglik, Y., Altay, M., Unal, V.S., Basarir, K. and Yildiz, Y. (2006) Manifestations and management of osteochondromas: A retrospective analysis of 382 patients. *Acta Orthop. Belg.* **72**, 748-755.

Secombe, C.J. and Anderson, B.H. (2000) Diagnosis and treatment of an osteochondroma of the distal tibia in a 3-year-old horse. *Aust. Vet. J.* **78**, 16-18.

Shupe, J.L., Leone, N.C., Olson, A.E. and Gardner, E.J. (1979) Hereditary multiple exostoses: clinicopathologic features of a comparative study in horses and man. *Am. J. Vet. Res.* **40**, 751-757.

Shupe, J.L., Leone, N.C., Gardner, E.J. and Olson, A.E. (1981) Hereditary multiple exostoses. Hereditary multiple exostoses in horses. *Am. J. Pathol.* **104**, 285-288.

Wilson, R.G., Auer, D.E. and Kelly, W.R. (1985) Multiple cartiilagenous exostoses in a horse. *Equine vet. J.* **17**, 462-465.

Wright, I.M. and Minshall, G.J. (2012) Clinical, radiological and ultrasonographic features, treatment and outcome in 22 horses with caudal distal radial osteochondromata. *Equine Vet. J.* **44**, 319-324.

Wuyts, W., Van Hul, W., De Boule, K., Hendrick, J., Bakker, E., Vanhoenacker, F., Mollica, F., Ludecke, H.J., Sayli, B.S., Pazzaglia, U.E., Mortier, G., Hamel, B., Conrad, E.U., Matsushita, M., Raskind, W.H. and Willems, P.J. (1998) Mutations in the EXT1 and EXT2 genes in hereditary multiple exostoses. *Am. J. Hum. Genet.* **62**, 346-354.

Zetterström, S.M., Johansson, D.C. and Carmalt, J.L. (2017) Evaluation of clinical and tenoscopic findings in the carpal flexor sheath of horses. *Am. J. Vet. Res.* **78**, 840-846.

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Case Report

Pantarsal arthrodesis in a pony using a locking compression plate

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Keywords: horse; pantarsal; arthrodesis; locking compression plate

Summary

A 20-year-old Welsh Pony cross presented with severe trauma of unknown aetiology to the right tarsus. Radiographic examination demonstrated a severely comminuted fracture of the tarsus with luxation (**Fig 1**). Fracture configuration rendered anatomic reconstruction and ultimate use of the tarsus impossible. Phenylbutazone (8.8 mg/kg bwt per os), ceftiofur (4.4 mg/kg bwt i.v.) and gentamicin 6.6 mg/kg bwt i.v.) were administered preoperatively. The pony was placed in left lateral recumbency with the affected limb uppermost. A curvilinear incision was made on the dorsal aspect of the tarsus in a proximal to distal direction, curving lateral and extending approximately 12 cm both proximal and distal to the talus. Proximally, the cranial tibial muscle was reflected laterally. Deep dissection extended through the extensor tendons to expose the dorsal aspect of the tibia, tarsocrural joint and MtIII. All exposed articular cartilage was removed using curettage. The distal tarsal joints were drilled using a 3.2 mm bit to facilitate ankylosis. A 14-hole, 5.5 mm locking compression plate (LCP) was applied to the dorsal aspect of the limb, and 5.5 mm cortex screws were placed in a distal first, then proximal direction to optimise compression of the LCP prior to placement of locking screws. Six 5.0 mm locking screws were then used to stabilise the tarsus. Following antimicrobial surgical rinse and incision closure, a full-limb cast was applied. Contralateral hoof support was provided prior to rope-assisted anaesthetic recovery, which was without incident. The pony was maintained on the antimicrobial regimen once daily for 7 days. Phenylbutazone was decreased to 4.4 mg/kg bwt per os b.i.d. and continued for 10 days. Omeperazole (1 mg/kg bwt per os) was administered for 30 days post-operatively. The pony was maintained in her cast for 30 days. The incision healed without incident and radiographs demonstrated fracture stability. The pony was confined to a stall for 90 days, then provided small pen turn out. Six months post-operatively, radiographs demonstrated complete arthrodesis (**Fig 2**). The pony had good conformation and range of motion at a walk and canter. The stride length of both pelvic limbs was similar. She was returned to light use as a child's mount and was ridden on the flat without incident. This report describes the first case of pantarsal arthrodesis in the horse using a locking compression plate. The application of a 5.5 mm LCP for pantarsal arthrodesis should be considered a viable treatment option for catastrophic failure of the equine tarsus.

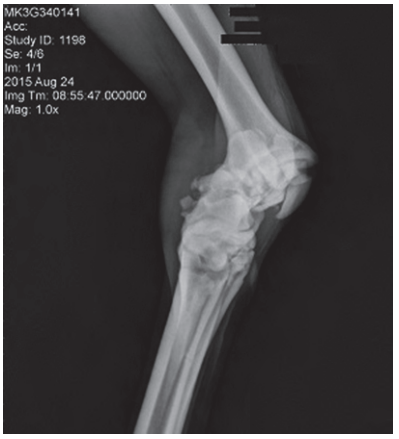

Fig 1: Severely comminuted fracture of the tarsus including the talus and distal tibia.

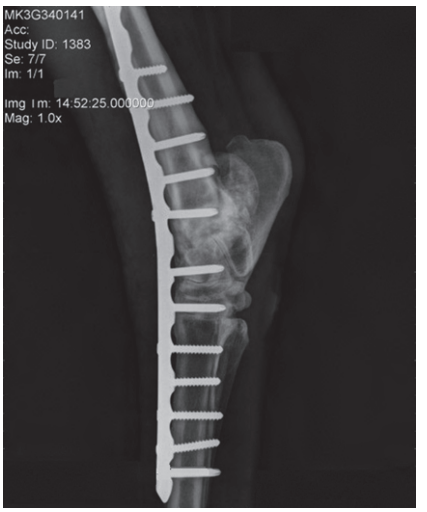

Fig 2: Lateral-medial projection demonstrating complete arthrodesis.

Key points

- This report describes the first case of pantarsal arthrodesis in the horse using a locking compression plate.
- Range of motion and stride length in this case of pantarsal arthrodesis provided satisfactory patient comfort and utility.
- The application of a 5.5 mm LCP for pantarsal arthrodesis should be considered a viable treatment option for catastrophic failure of the equine tarsus.

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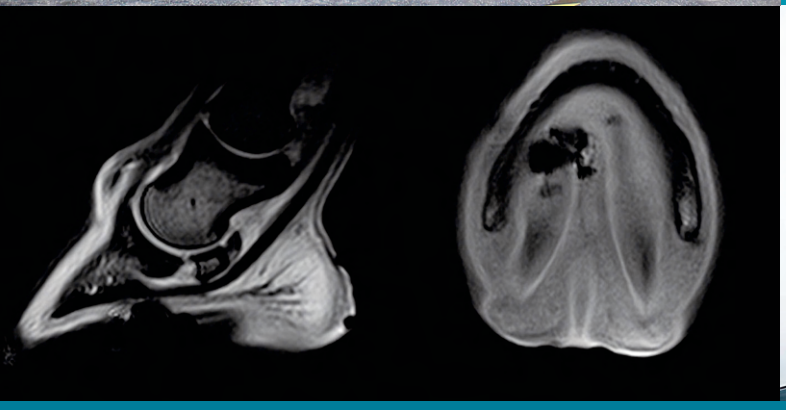

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Clinical Commentary

Tarsal arthrodesis in horses

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Keywords: horse; tarsal; arthrodesis

Summary

In this commentary, first the do's and don'ts of arthrodesis are discussed followed by a description of the different techniques of partial tarsal arthrodesis. Specific comments were made to discuss the case report in this issue by Vlahos (2020) with regards to the plate positioning and at the end some thoughts on pantarsal arthrodesis in adult horses are presented.

Introduction

In the past, the only described techniques in the literature of tarsal arthrodesis were 'partial' or 'subtotal' tarsal arthrodesis, contrary to the carpal region, where pancarpal techniques have been described in detail (Auer *et al.* 1990; Lischer and Auer 2018). The case report published in this issue of EVE represents the first description of a pantarsal arthrodesis in a pony (Vlahos 2020).

For any arthrodesis, as much cartilage as possible should be removed from the opposing bone surfaces, allowing maximum bone-on-bone contact, because articular cartilage inhibits vascular invasion and ossification (Adams 1970; McIlwraith and Turner 1987; Zamos and Honnas 1993). Remaining cartilage can deteriorate but usually some islands will persist even with surrounding bone-to-bone fusion. Joint immobility and compression are best accomplished by placing a combination of multiple transarticular screws in lag fashion and bone plates. The recently introduced locking plates have shown improved stability and therefore represent the implants of choice in horses (Levine and Richardson 2007; Richardson 2008; Brandenberger *et al.* 2018). Cancellous bone grafts can be added to the constructs but are rarely included.

The primary indication for arthrodesis in the tarsal region is osteoarthritis of the small tarsal joints (Edwards 1982; Wyn-Jones and May 1986; Lischer and Auer 2018) as well as the talocalcaneal joint (Pauwels *et al.* 2005). Occasionally, luxations of the tarsus, especially involving the tarsometatarsal (TMT) and distal intertarsal (DIT) joints, necessitate an arthrodesis (Kenneth 2001; McCormick and Watkins 2014; Keller *et al.* 2015).

Techniques

Partial tarsal arthrodesis

Chemically (Bohanon *et al.* 1991; Shoemaker *et al.* 2006) and laser (Hague and Guccione 2002; Lamas *et al.* 2012) induced ankylosis of one or both small tarsal joints are the most frequently applied techniques, followed by intra-articular drilling causing local cartilage removal (Adams and Fessler 2000; Lischer and Auer 2018). The estimates of outcome following transarticular drilling suggest that this treatment may be successful in 47–85%, depending on the technique and study design (Voûte *et al.* 2009).

The other option is fixation of the involved joint with implants. Plates are applied in most cases dependent upon the location of the problem. Presently, the use of locking implants is preferred. In cases of arthrodesis of the small tarsal joints, a plate is applied to the medial aspect of the tarsal region with screws inserted into the central and third tarsal bones as well as the third metatarsal bone (MtIII). Lately additional oblique transarticular screws inserted in lag fashion on either side of the plate were added to achieve compression at the medial aspect of the tarsal region, similar to the technique applied in the proximal interphalangeal arthrodesis (Lischer and Auer 2018). This technique results in a more stable fixation providing more comfort in the early post-operative period.

Cartilage of the TMT and the DIT joint is partially removed using the drilling technique described previously (Voûte *et al.* 2009). These holes may be filled with a bone graft plug harvested from the proximal tibia or the tuber coxae (von Salis *et al.* 2000). Placement of such a plug, hydroxyapatite granules, or biodegradable bone cement will enhance osseous union of the two articulations by means of spot welds.

The recently developed LCP T-plate (**Fig 1**) represents the implant of choice for this type of arthrodesis. It is applied dorsomedially through the skin incision (Lischer and Auer 2018). Minimal contouring is usually required. The T-plate is placed minimally invasively by pushing it distally between the skin and the dorsomedial aspect of MtIII. The screws in the MtIII are inserted through stab incisions (**Fig 2**). Again, additional cortex screws inserted in lag fashion are applied in oblique direction on either side of the plate.

An alternative technique for arthrodesis involves implanting perforated stainless steel cylinders filled with autogenous cancellous bone in the distal tarsal joints (Archer *et al.* 1988). However, this technique is rarely applied.

Luxation of one of the distal tarsal joints is a good indication for arthrodesis using plates (**Fig 3a**). In cases of subluxation of one of these joints, the intact soft tissues may be used to provide good stability. In these cases, the plate is applied opposite the intact soft tissues (**Fig 3b**). Complete luxations (**Fig 4a**) are a real challenge and frequently demand the use of two plates. Application of a plantarolateral plate spanning the calcaneus, tarsal region and fourth- (MtIV) and third metatarsal bone (MtIII) (**Fig 4b**) in combination with a shorter plate applied at 90° relative to the first plate provides a strong fixation (McCormick and Watkins 2014). As much cartilage as possible is removed from the affected joint using a curette. After reduction of the luxation, the head of the MtIV is trimmed with a chisel to

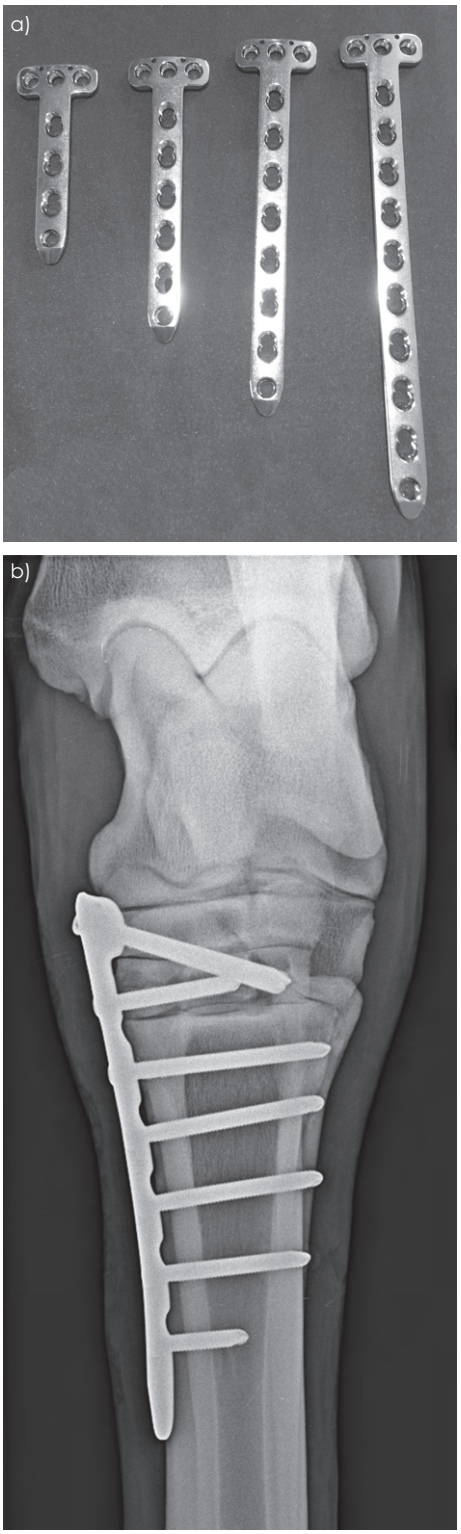

Fig 1: a) The four different sizes of the equine T-plate. For a partial tarsal arthrodesis, the two smaller sizes are adequate. b) Dorsoplantar radiographic view of the precursor to the equine T-plate applied to the tarsal region of an adult horse.

facilitate good bone-plate contact along the entire arthrodesis site. An alternative approach involves removal of the entire MtIV. Depending on the size of the horse, a 9- to 16-hole narrow or broad 4.5 DCP or a 4.5/5 LCP is typically applied.

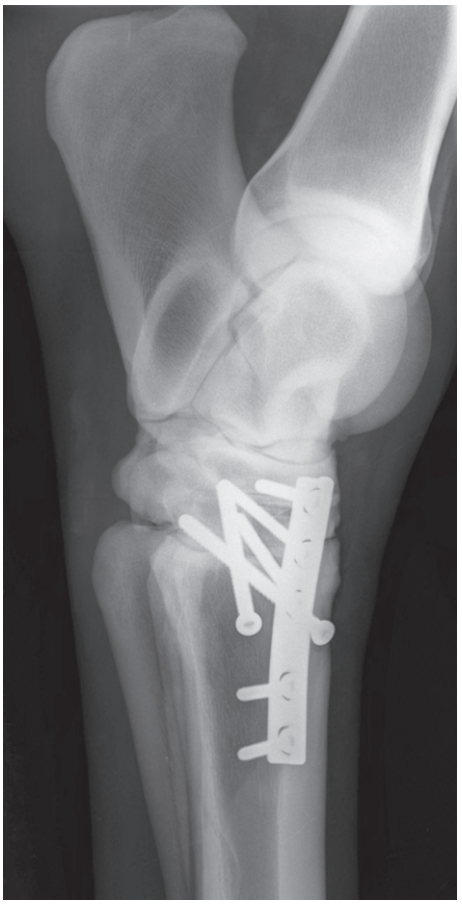

Fig 2: Oblique radiographic view of an arthrodesis of the tarsometatarsal- and distal intertarsal joints with the help of a narrow 5-hole DCP. One 5.5 mm cortex screw is inserted obliquely on either side of the plate across the involved joints. Additionally, the middle screw in the plate also crosses the tarsometatarsal joint.

Talocalcaneal arthrodesis is only performed in confirmed cases of proximal intertarsal instability and/or arthritis. The treatment involves the insertion of two or three 5.5 mm cortex screws in lag fashion across the lateral facet using routine technique. There should be an adequate amount of solid bone present to achieve stable transarticular compression. By slightly diverging the direction of the screws, an increased compressive effect can be achieved. To prevent countersinking the calcaneus, washers may be applied (Auer 2018). Alternatively, the screws may be inserted through a plate contoured to the calcaneal surface.

Pantarsal arthrodesis

Pantarsal arthrodesis is a well-established technique in small animal surgery (DeCamp *et al.* 1993; Dyce *et al.* 1998; Wilke *et al.* 2000; Fettig *et al.* 2002; McKee *et al.* 2004; Roch *et al.* 2008). Up until recently, the plates were applied either to the medial or the lateral aspect of the tarsal region. Because of the fact that small animals have four major metatarsal bones (MtI is much smaller and positioned further plantarly), the distal screws needed to cross several of these bones to

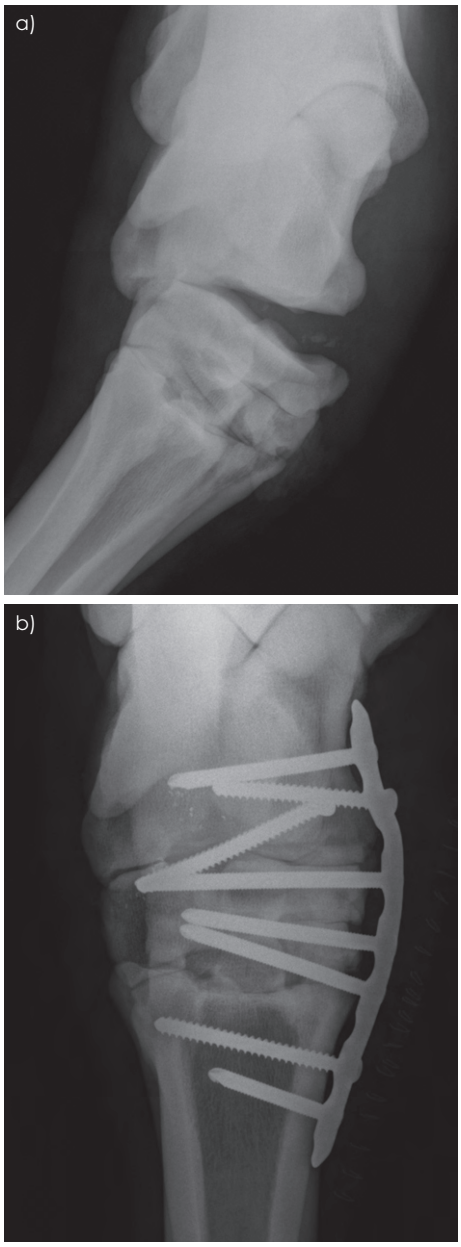

Fig 3: a) Dorsoplantar radiographic view of a subluxation of the proximal intertarsal joint in an adult horse. b) Dorsoplantar radiographic view of the internal fixation. A 7-hole broad LCP is applied to the medial aspect of the tarsal region (opposite the intact soft tissues). Note, one additional screw crosses the proximal intertarsal joint, whereas two locking head screws applied through the plate cross the tarsometatarsal and distal intertarsal joints.

provide adequate stability. Needless to say, these surgical procedures resulted in a high complication rate (Roch *et al.* 2008). Lately, several surgical implant companies started to offer hybrid plates that could be applied to the cranial/dorsal aspect of the tibial/tarsal region (**Fig 5**). These plates are thicker and wider in the distal tibial region and thinner and narrower in the metatarsal region. The plate allows screw insertion in MtIII only. Application of a plate to the medial or lateral aspect of the tarsal region is mechanically more stable

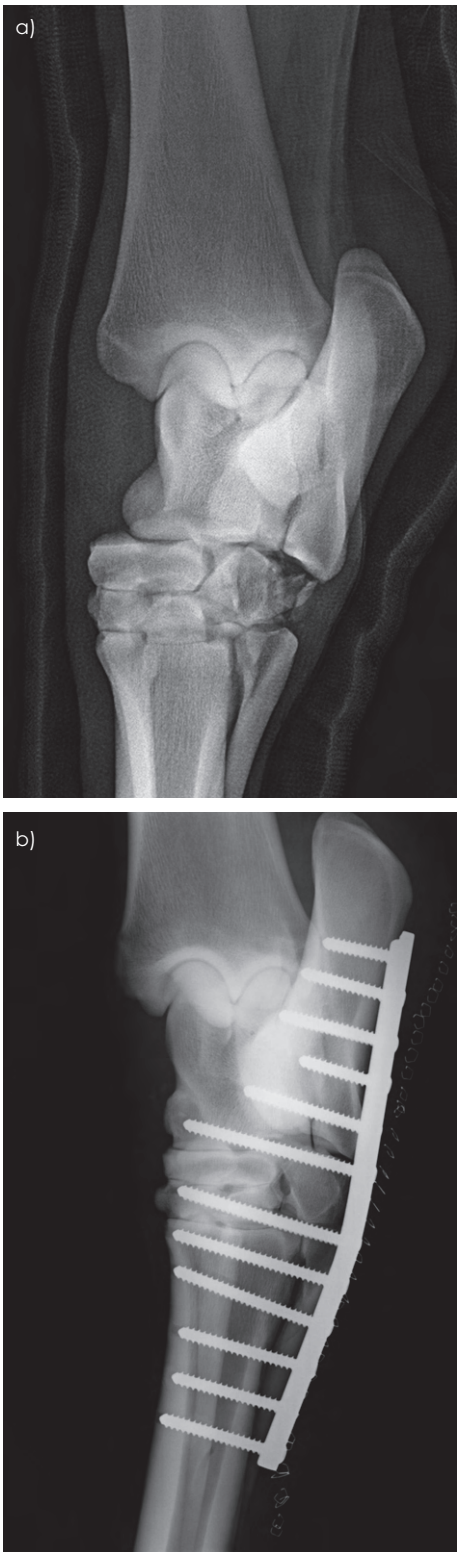

Fig 4: a) Dorsoplantar radiographic view of a complete luxation of the proximal intertarsal joint in an adult horse. b) Oblique radiographic view of the repair. A 12-hole broad DCP is applied to the plantarolateral aspect of the calcaneus, the tarsal region and the proximal aspect of MtIII and MtIV. Note two screws through the plate were inserted transarticularly. In this case, only one plate was applied.

because the plate is stressed side-to-side not front to back as is the case in a dorsally applied plate. One technique described involves plantar plate application for tarsal and tarsometatarsal arthrodesis only (Wilke *et al.* 2000). Because of the complex anatomical situation in that region, this technique was abandoned. From a biomechanical standpoint, application of a plate to the plantar aspect of the tarsal region is stronger because plates are strongest under tension and weakest in compression (Disegi 2018). Therefore, one key principle in plate application, especially in horses, is to position one plate to the tension surface of the bone/region. To partially offset this shortcoming when the plate is applied to the cranial/dorsal aspect of the tibial/tarsal/metatarsal region, some small animal surgeons insert a screw from the plantar aspect of the calcaneus in cranial direction into the tibia. Again, this technique is associated with a high complication rate (Roch *et al.* 2008).

As mentioned earlier, pantarsal arthrodesis has up to now only been reported in the case report in this issue of Equine Veterinary Education (Vlahos 2020). The surgeon applied a 5.5 mm LCP to the cranial/dorsal aspect of the tibial/tarsal/metatarsal region in a Welsh Pony cross weighing 250 kg. From a biomechanical aspect, this plate location is the weakest possible and, in most cases, would be doomed to failure. In the equine metacarpo/metatarsophalangeal arthrodesis, plates are routinely applied to the dorsal aspect of the joint region (Bramlage 1996; Lischer and Auer 2018). However, in this technique a tension band is routinely applied to the palmar/plantar aspect of joint using heavy-duty cerclage wire or cables. In cases where the suspensory apparatus is intact, screws inserted across McIII/MtII into the

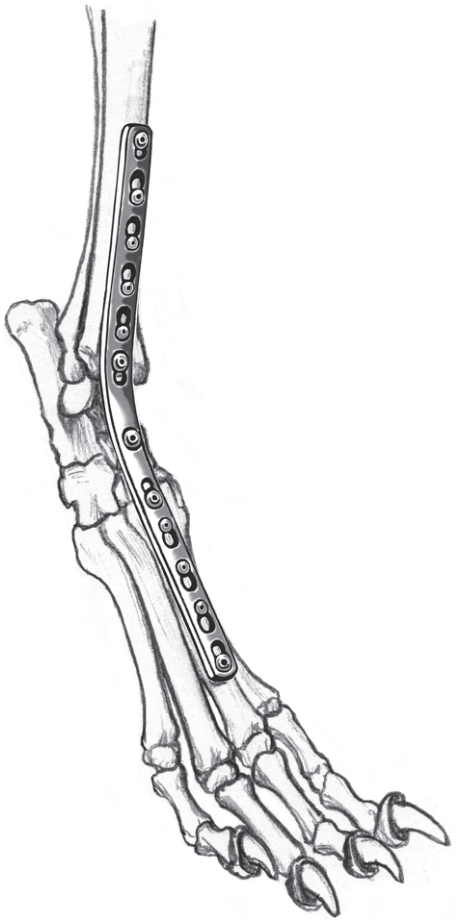

Fig 5: Artist drawing of hybrid pancarpal arthrodesis plate applied to the cranial/dorsal tarsal region of a dog. Note, the distal part of the plate is smaller than the proximal one.

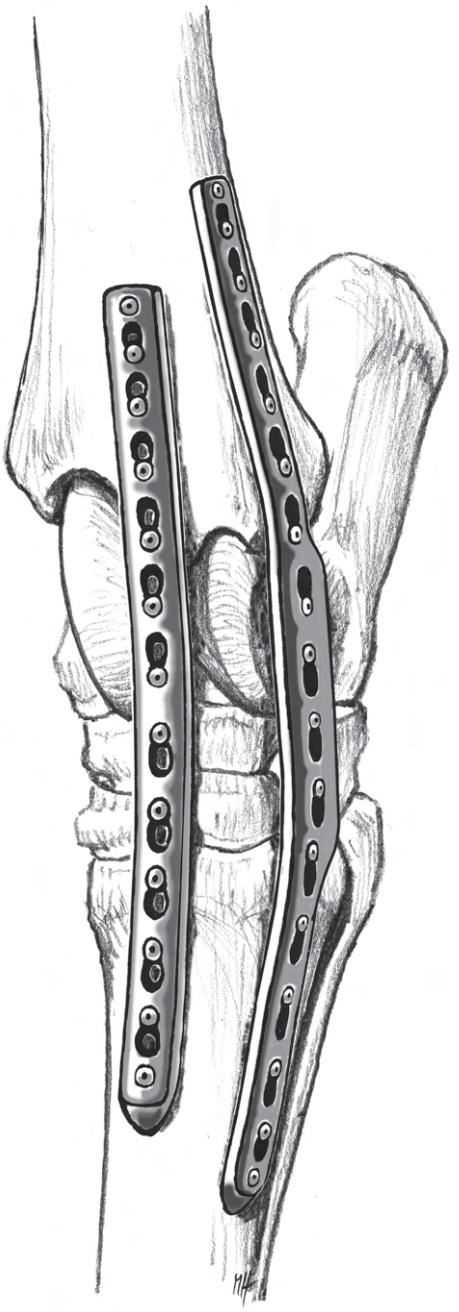

Fig 6: Artist drawing of a pantarsal arthrodesis in a horse. A 17-hole broad L-shaped LCP with a wider aspect in the middle is shown on the lateral aspect of the tibia, the tarsal region and the proximal aspect of MtIII (Note, this plate does not exist yet) and a 13-hole broad 5.5 mm veterinary LCP spans the cranial/dorsal aspect of the tarsal region. Only locking head screws were drawn. The veterinary LCPs have one pointed and beveled end and one rounded end.

proximal sesamoid bones take over the function of a palmar/plantar tension band. It is because of these additional procedures that dorsal plate application for metacarpo/metatarsophalangeal arthrodesis is successful.

The case described in the mentioned equine case report was successful because of two main reasons: (1) The patient had a relatively low body weight and (2) The plate used for this case was theoretically much too big (5.5 mm). This does in no way mean that the surgeon did not perform an excellent job in this case, but it explains to some extent the reasons why it worked. Applying external coaptation for one month represents reasonable case management. The problem encountered with two screw holes that had to be left open could have possibly been avoided if the surgeon started with screw insertion towards both ends of the plate assuring that there was bone contact along the entire plate.

Applying a pantarsal arthrodesis in a horse results in a 'very long bone' once the joints are fused. As with shoulder arthrodesis (Semevolos *et al.* 2003), this technique will be more successful in smaller horses and ponies. The benefit for such a procedure in a horse compared to a dog is, that the size of the tibia relative to MtIII is more equal in horses than in dogs, which results in better biomechanical situation in MtIII. It is this author's opinion that in an adult large horse application of one plate alone to the cranial/dorsal aspect of the tarsal region to achieve a pantarsal arthrodesis is not sufficient. Theoretically, a L-plate (not presently available) should be applied either to the lateral or medial aspect of the bone (**Fig 6**). However, the chances that such a plate will ever be developed are very slim, considering the number of cases that will be treated.

Authors' declaration of interests

No conflicts of interest have been declared.

Ethical animal research

Not applicable to this clinical commentary.

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Authorship

Both authors contributed to this clinical commentary.

References

Adams, O.R. (1970) Surgical arthrodesis for treatment of bone spavin. *J. Am. Vet. Med. Assoc.* **157**, 1480-1487.

Adams, S.B. and Fessler, J.F. (2000) Surgical treatment of bone spavin. In: *Atlas of Equine Surgery*. Eds: S.B. Adams and J.F. Fessler, WB Saunders, Philadelphia. pp 371-378.

Archer, R.M., Schneider, R.K., Lindsay, W.A. and Wilson, J.W. (1988) Arthrodesis of the equine distal tarsal joints by perforated stainless steel cylinders. *Equine Vet. J.* **20**, *Suppl.* **6**, 125-130.

Auer, J.A. (2018) Principles of internal fixation. In: *Equine Surgery*, 5th edn., Eds: J.A. Auer, J.A. Stick, J.M. Kümmerle and T. Prange, Elsevier Saunders, Philadelphia. pp 1277-1314.

Auer, J.A., Taylor, J.R., Watkins, J.P., Welch, R.D. and Stricklin, J.B. (1990) Partial carpal arthrodesis in the horse. *Vet. Comp. Orthop. Traumatol.* **3**, 51-60.

Bohanon, T.C., Schneider, R.K. and Weisbrode, S.E. (1991) Fusion of the distal intertarsal joints and tarsometatarsal joints in the horse using intra-articular sodium monoiodacetate. *Equine Vet. J.* **23**, 289-295.

Bramlage, L. (1996) Fetlock arthrodesis. In: *Equine Fracture Repair*. Ed: A. Nixon, WB Saunders, Philadelphia. pp 172-178.

Brandenberger, O., Rossignol, F., Bartke, S., Van Bergen, T. and Vitte, A. (2018) Carpal arthrodesis using a minimally invasive approach and locking compression plates: three cases. *Equine Vet. Educ.* **30**, 229-236.

DeCamp, C.E., Martinez, S.A. and Johnston, S.A. (1993) Pantarsal arthrodesis in dogs and a cat: 11 cases (1983-1991). *J. Am. Vet. Med. Assoc.* **203**, 1705-1707.

Disegi, J.A. (2018) Metallic implants and instruments. In: *Equine Surgery*, 5th edn., Eds: J.A. Auer, J.A. Stick, J.M. Kümmerle and T. Prange, Elsevier Saunders, Philadelphia. pp 1270-1277.

Dyce, J., Whitelock, R.G., Robinson, K.V., Forsythe, F. and Houlton, J.E. (1998) Arthrodesis of the tarsometatarsal joint using a laterally applied plate in 10 dogs. *J. Small Anim. Pract.* **39**, 19-22.

Edwards, G.B. (1982) Surgical arthrodesis for the treatment of bone spavin in 20 horses. *Equine Vet. J.* **14**, 117-121.

Fettig, A.A., Mccarthy, R.J. and Kowaleski, M.P. (2002) Intertarsal and tarsometatarsal arthrodesis using 2.0/2.7-mm or 2.7/3.5-mm hybrid dynamic compression plates. *J. Am. Anim. Hosp. Assoc.* **38**, 364-369.

Hague, B.A. and Guccione, A. (2002) Laser-facilitated arthrodesis of the distal tarsal joints. *Clin. Tech. Equine Pract.* **1**, 32-35.

Keller, S.A., Fürst, A.E., Kircher, P., Ringer, S. and Kümmerle, J.M. (2015) Locking compression plate fixation of equine tarsal subluxations. *Vet. Surg.* **44**, 949-956.

Kenneth, E.S. (2001) The Tarsus. In: *Adams' Lameness in Horses*, 5th edn., Ed: T. Stashak, Lippincott Wiliams & Wilkins, Philadelphia. pp 931-946.

Lamas, L.P., Edmonds, J., Hodge, W., Zamora-Vera, L., Burford, J., Coomer, R. and Munroe, G. (2012) Use of ethanol in the treatment of distal tarsal joint osteoarthritis: 24 cases. *Equine Vet. J.* **44**, 399-403.

Levine, D.G. and Richardson, D.W. (2007) Clinical use of the locking compression plate (LCP) in horses: a retrospective study of 31 cases (2004-2006). *Equine Vet. J.* **39**, 401-406.

Lischer, C.J. and Auer, J.A. (2018) Arthrodesis techniques. In: *Equine Surgery*, 5th edn., Eds: J.A. Auer and J.A. Stick, Elsevier Saunders, Philadelphia. pp 1374-1398.

McCormick, J.D. and Watkins, J.P. (2014) Plate fixation for management of plantar instability of the distal tarsus/proximal metatarsus in 5 horses. *Vet. Surg.* **43**, 425-429.

McIlwraith, C.W., Turner, A. S. (1987) Orthopedic surgery. In: *Equine Surgery: Advanced Techniques*, Eds: C.W. McIlwraith and A.S. Turner, Lea & Febiger, Philadelphia. pp 179-182.

McKee, W., May, C., Macias, C. and Lapish, J.P. (2004) Pantarsal arthrodesis with a customised medial or lateral bone plate in 13 dogs. *Vet. Rec.* **154**, 165-170.

Pauwels, F.E., Adams, S.B. and Blevins, W.B. (2005) Arthrodesis of the talocalcaneal joint for the treatment of two horses with talocalcaneal osteoarthritis. *Vet. Comp. Orthop. Traumatol.* **17**, 7-12.

Richardson, D.W. (2008) Less invasive techniques for equine fracture repair and arthrodesis. *Vet. Clin. North Am. Equine Pract.* **24**, 177-189.

Roch, S.P., Clements, D.N., Mitchell, R.A., Downes, C., Gemmill, T.J., Macias, C. and McKee, W.M. (2008) Complications following tarsal arthrodesis using bone plate fixation in dogs. *J. Small Anim. Pract.* **49**, 117-126.

von Salis, B., Auer, J.A. and Fackelman, G.E. (2000) Small tarsal joint arthrodesis. In: *AO Principles of Equine Osteosynthesis: An Electronic Manual of the AO/ASIF Technique*. Eds: G.E. Fackelman, D.M. Nunamaker, J.A. Auer, Thieme Verlag, Stuttgart, Germany. pp 269-280.

Semevolos, S.A., Watkins, J.P. and Auer, J.A. (2003) Scapulohumeral arthrodesis in miniature horses. *Vet. Surg.* **32**, 416-420.

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Case Report

Complex stifle injury in a foal

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Keywords: horse; stifle; computed tomography; cranial cruciate ligament; meniscus; foal

Summary

A 130 kg, 60-day-old Quarter Horse male foal presented with bilateral stifle effusion and severe left hindlimb lameness. Clinical examination revealed good body condition and pain on medial palpation of the left stifle. Stifle radiography demonstrated irregular proximal margins to the medial trochlear ridges and severe femoropatellar effusion. Bilateral arthrocentesis was performed under injectable anaesthesia and did not reveal septic arthritis. The foal was administered oral anti-inflammatories and stall confined for several days but the lameness did not improve. Eleven days after presentation, the foal was anaesthetised and stifle ultrasound and computed tomography were performed. The additional imaging revealed disruption of the left medial meniscus (**Fig 1**), deep bone injury to the left medial femoral condyle (MFC), and evidence of injury to the origin of the cranial cruciate ligaments in both stifles. Further treatment consisted of 8 weeks of stall rest and joint injection with corticosteroids but did not improve the lameness. Due to the poor prognosis for soundness, the foal was euthanised 10 weeks after initial presentation. On gross post-mortem examination of the left stifle, fibre disruption was present on the femoral and tibial surfaces of the medial meniscus, the cranial cruciate ligament origin was avulsed from the lateral femoral condyle, and there was a 3 × 10 mm full thickness osteochondral injury on the cranial MFC. MFC cartilage staining with India ink also indicated a 10 × 12 mm area of superficial cartilage fibrillation on the central MFC. Gross post-mortem examination of the right stifle revealed partial avulsion of the origin of the cranial cruciate ligament. Histologic examination of damage to the left stifle confirmed severe disruption of the collagen fibres on the femoral and tibial surfaces and abaxial margin of the medial meniscus, a loss of articular cartilage with deeper fibrosis in the cranial MFC lesion, and superficial cartilage fibrillation and cartilage and trabecular bone thickening in the central MFC lesion.

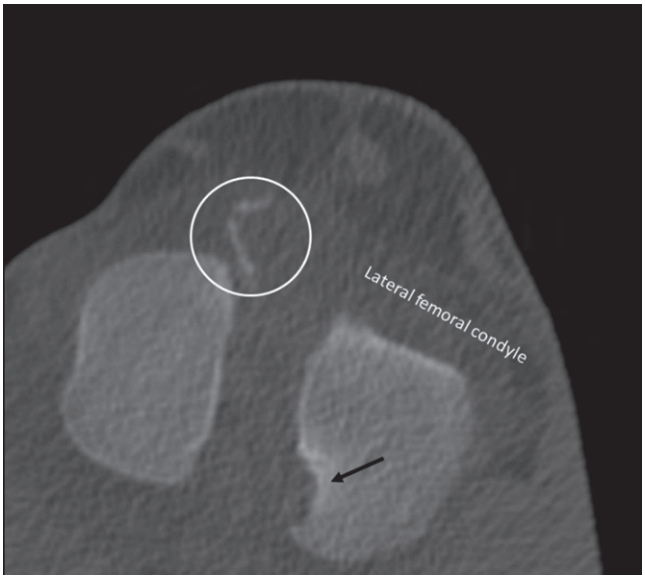

Fig 1: Day 11 after injury: Single transverse computed tomographic image of left stifle immediately proximal to condylar cartilage. Arrow indicates site of avulsion of cranial cruciate ligament from the lateral femoral condyle, circle indicates mineralised fragments in torn aspect of ligament.

Key points

- Foals as young as 60 days can be affected with severe traumatic soft tissue injuries of the stifle joints.
- Stifle radiography, ultrasound and computed tomography can determine the severity of a stifle injury, establish a prognosis, and direct therapy.
- Complete disruption of the origin of the cranial cruciate ligament and severe meniscal damage in this foal indicated that the most likely result was persistent severe lameness and euthanasia was performed for humane reasons.

EQUINE VETERINARY EDUCATION
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Case Report

Lumbar fractures in a 5-year-old Warmblood cross gelding

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Keywords: horse; vertebral body; endplate; pelvis; spine

Summary

A 5-year-old Warmblood × Cob gelding used for low-level activities presented with a history of unusual gait abnormalities of 2 weeks' duration and no known history of trauma. On presentation, the horse was distressed, guarded himself and showed a marked pain response to pressure applied lateral to the right tuber sacrale. At walk and trot, the horse tilted the pelvis to the left. The horse was in great discomfort and showed hindlimb instability when a tail pull test to the right was performed. When stopping after turning in tight circles to the right, he held up the right hindlimb in spasm.

Per rectum ultrasonographic examination revealed a large defect in the ventral aspect of the sixth lumbar vertebral body close to the lumbosacral disc (**Fig 1**). Further cranially, the ventral aspect of the sixth lumbar vertebral body was disrupted, indicating displacement of a fragment. There were several small echogenic areas in the region of the right sixth lumbar nerve root. Diagnosis of a fracture of the sixth lumbar vertebral body was made.

Due to the potential risk of quick progression of neurological signs and pain, posing a great threat to the horse's welfare and safety concerns for personnel, the horse was subjected to euthanasia.

Post-mortem computed tomography of the pelvis confirmed multiple fractures of the sixth lumbar vertebral body (**Fig 2**) and revealed new bone formation around the fracture sites and new bone protruding into the intervertebral foramina between the sixth lumbar and first sacral vertebrae.

This case demonstrates the value of per rectum ultrasonographic examination in the diagnosis of pelvic injuries in live horses. This is the first documented case of lumbar fracture in a non-racehorse with no history of trauma.

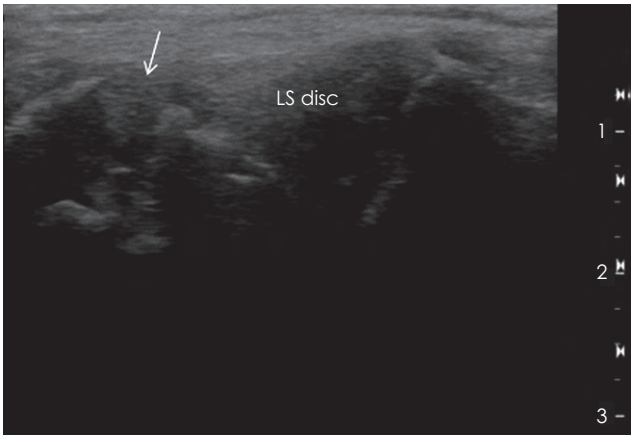

***Fig 1:** Per rectum longitudinal ultrasonographic image showing a large defect in the ventral aspect of the sixth lumbar vertebral body (arrow). LS, lumbosacral.*

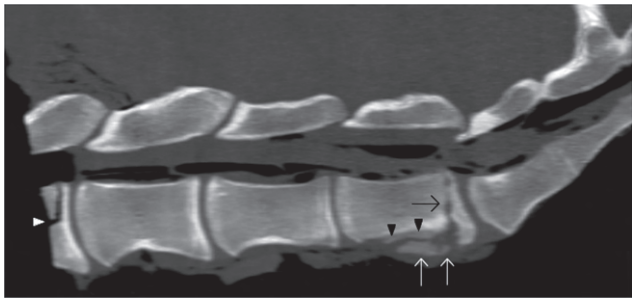

***Fig 2:** Parasagittal computed tomographic image of the caudal lumbar spine and the cranial aspect of the sacrum showing a complete fracture of the caudal endplate of the sixth lumbar vertebral body (black arrow) and a large defect just cranial to the endplate. There are two fragments separated from the ventral aspect of the bone (white arrows). There is irregular new bone on the ventral aspect of the parent bone (black arrowheads). A fracture of the third lumbar vertebral body is just visible in the edge of the field of view (white arrowhead).*

Key points

- Per rectum ultrasonography can aid in vivo diagnosis of lumbar fractures.
- If clinical findings are suggestive, lumbar fractures should be considered in non-racing horses.
- Lumbar fractures should be considered in horses with no known history of trauma.

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Case Report

Surgical repair of synovial fistulae between a carpal hygroma, the tendon sheath of the extensor carpi radialis and the antebrachiocarpal joint in a horse

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Keywords: horse; carpus; tendon sheath; hygroma; fistulae

Summary

A 7-year-old Thoroughbred cross Warmblood used for eventing was presented for examination of a chronic swelling on the dorsal aspect of the left carpus extending distally to the proximal third metacarpus. The horse had a history of trauma to the dorsal carpus several months previously. The trauma was assumed to be from hitting a cross-country jump with the carpus flexed whilst eventing. No laceration was present and the owners treated the swelling symptomatically with box rest, cold hosing and oral phenylbutazone. The horse was sound after 48 h and the owners returned to exercise after 2 weeks. No lameness recurred, however, the dorsal carpal swelling increased with exercise and the owners sought referral after 3 months. Routine radiographs of four standard views of carpus and flexed lateral-medial projection showed no osseous abnormalities. Ultrasonographic examination revealed subcutaneous fluid accumulation within a cavity. A communication between carpal joints and extensor carpi radialis (ECR) tendon sheath could not be confirmed. Differential diagnoses included subcutaneous hygroma of the carpus, hygroma communicating with synovial structures, ganglion, cyst and synovial herniation. To distinguish between these conditions, contrast radiography was performed by injecting 10 mL iohexol (Omnipaque)[1] in 10 mL 0.9% saline into the superficial cavity using aseptic technique. This demonstrated distention of the dorsal cavity and passage of contrast into the antebrachiocarpal (ABC) joint and ECR tendon sheath and confirmed that the dorsal cavity was a synovial hygroma with communication leading to the ABC joint and ECR tendon sheath. Due to the owner's concerns regarding increasing dorsal swelling and the potential for a superficial wound sustained during eventing to result in synovial sepsis, surgical intervention to repair the synovial fistulae was recommended. This was carried out under general anaesthesia (**Fig 1**). The horse returned to competition 4 months post-operatively successfully eventing at the previous level. There was no restriction to carpal flexion 12 months after the surgery, however, a moderate fibrous swelling over the dorsal aspect of the left carpus was present as a cosmetic defect. Ultrasonographic examination revealed the presence of organised fibrous tissue containing multiple small blood vessels, but with no evidence of fistulation of the ABC joint or ECR tendon sheath and no recurrence of the carpal synovial hygroma.

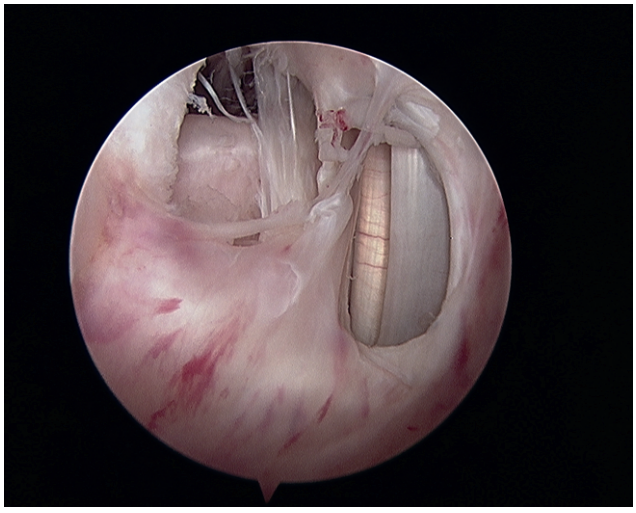

Fig 1: Arthroscopic view, the dorsal aspect of the carpal bones in the ABC joint and the ECR tendon within the ECR tendon sheath could be seen through the fistulae.

Key points

- Traumatically-induced hygroma, or false bursa, in the subcutaneous tissues over the dorsal aspect of the carpus are relatively common in horses.
- Ultrasonography alone may not be successful in demonstrating synovial fistulae or synovial membrane herniation.
- These conditions communicating with synovial structures require surgical repair of the synovial membrane rather than open drainage and pressure bandaging, where an infection arising from an open drain could lead to synovial sepsis.

Manufacturer's address

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Original Article

Hypothermia prevention in long-standing equine dental procedures

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Keywords: horse; air-warming; dental procedures; hypothermia; prevention

Summary

Hypothermia is a common, detrimental post-operative complication in man and veterinary medicine. Active warming strategies are paramount for prevention and treatment. Duration of operations, administered drugs and their adverse effects put horses undergoing procedures requiring long-standing sedation in danger of hypothermia. The aim of this study was to investigate whether an air warming device would be helpful to avoid severe hypothermia in adult horses. Twenty client-owned horses undergoing dental/sinusoidal procedures were divided into two equal groups. The treatment group was covered with a warming blanket connected to the warming device with the temperature set to 43°C. Horses in the control group were not blanketed. Temperature was measured at the time of first sedation (T0) and every hour throughout the length of the procedure. Use of the warming blanket was straightforward and caused no adverse reactions. The mean decrease in body core temperature in the treatment group was significantly less than the mean temperature decrease in the control group, beginning at the second hour of the procedure. No horse in the treatment group reached a body temperature below 36°C. Overall loss of temperature in the control group was more than double when compared with the treatment group (1.5°C and 0.7°C respectively). The use of an active air warming blanket in horses is an easy technique to prevent hypothermia in horses undergoing long-standing sedation procedures.

Introduction

Hypothermia is a decrease in body core temperature (BCT) below physiological values. It is considered to be a common finding in humans, small animals and horses undergoing general anaesthesia (Janicki *et al.* 2002; Mayerhofer *et al.* 2005; Moola and Lockwood 2011). Even though hypothermia has positive neuroprotective features, most commonly detrimental effects on living organisms override this advantage. Despite shivering, which increases oxygen consumption by 40%, hypothermia causes an adrenergic stress response in the body, increasing the concentration of norepinephrine up to 500% in human subjects (Frank 2001). Reduction in BCT not only causes vasoconstriction and increased risk of ventricular dysrhythmias, but also influences the coagulation cascade impairing platelet function as well as coagulation factors, while enhancing fibrinolysis. Because of decreased oxygen partial pressure in tissues and impaired function of neutrophils and macrophages, the risk of bacterial wound infection is increased (Pietsch *et al.* 2007). With every Celsius degree loss of temperature, metabolic rate slows down as well as metabolism of medication which can cause inadvertent overdose (Frank 2001; Pietsch *et al.* 2007). Unfortunately, hypothermia was found in all equine cases undergoing general anaesthesia for greater than 45 min (Mayerhofer *et al.* 2005). Horses undergoing long-standing sedation are also in danger of hypothermia due to reduced muscle tone, and thereby heat production. All sedation protocols for adult horses are based on use of alpha-2 agonists, whose influence on thermoregulation directly impacts heat production and perception in other species (Szreder 1993; Madden *et al.* 2013). In human medicine active warming systems with either warm water or air are routine management of perioperative hypothermia (Janicki *et al.* 2002; Moola and Lockwood 2011; Adderley 2015). To the best of the authors' knowledge, there are no published trials to prevent hypothermia in equine cases undergoing long-standing sedation procedures. The aim of this study was to investigate whether an air warming device would be helpful to avoid severe hypothermia in adult horses.

Materials and methods

Horses

The study was conducted in 20 horses admitted to the Equine Hospital of University of Veterinary Medicine in Vienna for diagnosis and treatment of dental or sinusoidal problems. All horses were considered healthy at clinical examination, apart from the localised dental/sinusoidal problem.

Sedation and warming protocol

The study was designed as prospective and randomised. All horses were sedated with 0.01 mg/kg detomidine hydrochloride (Equidor)[1] and 0.01 mg/kg butorphanol (Alvagesic)[2] prior to catheter placement (12 gauge) in one jugular vein; sedation to effect was maintained with detomidine-butorphanol constant rate infusion titrated to a dose which allowed continuation of the procedure. Infusions of lactated ringer's solution[3] at the rate of 5 mL/kg bwt/h were given throughout the entire procedure. In all cases local anaesthesia was performed with mepivacaine hydrochloride (Mepinaest purum 2%)[4] (infiltration, splash and/or nerve block). Room temperature was recorded and maintained between 20 and 22°C. As previously published in horses, rectal temperature of all horses was controlled at T0- time of initial sedation and then every hour until the end of the procedure (Tomasic and Nann 1999). Temperature measurements in all horses were performed with an identical thermometer designed for use in veterinary medicine. Minimum procedure duration of 3 h was based on the authors' opinion that the longer the procedure, the greater the likely corresponding loss of BCT. In the treatment group (n = 10), horses were covered with the warming blanket

immediately after sedation and warm air flow was initiated with the highest possible temperature setting of 43°C. In order to minimise movement of the warming blanket on the horses, a stall blanket was placed over the warming air blanket. The Air Warming Device used in the current study is one of the routinely used at our small animal anaesthesia department and consists of a paper blanket with small openings to blow warm air in the direction of patient, hoses and the device itself which can blow air at two speeds and three possible temperature settings. Both blankets were re-adjusted as needed during the procedure upon movement of the horse. Horses in the control group underwent the same protocol but no blankets were applied after the animal was sedated. For each horse: age, weight, sex, procedure length and BCT were recorded and compared. The warming blanket set-up is shown in **Figures 1** and **2**.

Data analysis

Data were analysed by one-way ANOVA in order to minimise type 1 errors. Each time point analysis was confirmed by T-test and all variables were analysed by F-test for equal variance. The study power was calculated to be 91.7%. A P value of <0.05 was used to set statistical significance.

Results

Twenty horses (6 mares, 2 stallions and 12 geldings) weighing 477 ± 128 kg with a mean age of 12 ± 7 years were included. Breeds that were represented were Warmblood-8, Pony-3, Noriker-2, Icelandic Horse-2, Haflinger-1, Quarter Horse-1, Standardbred-1, Arabian-1, Pura Raza Espanola-1. The warming blanket was easy to apply and keep in place for use throughout the entire sedation period in all horses for dental/sinusoidal procedures. Minimal dislocations of the blanket were easily corrected. No adverse reactions were observed. Results are summarised in **Table 1**. The decrease in BCT in the study group was significantly less from the second hour of the procedure (P = 0.04) onward. No horse in the study group reached a BCT less than 36°C. Mean loss of temperature in the control group was more than twice that in the study group (1.5°C and 0.7°C respectively).

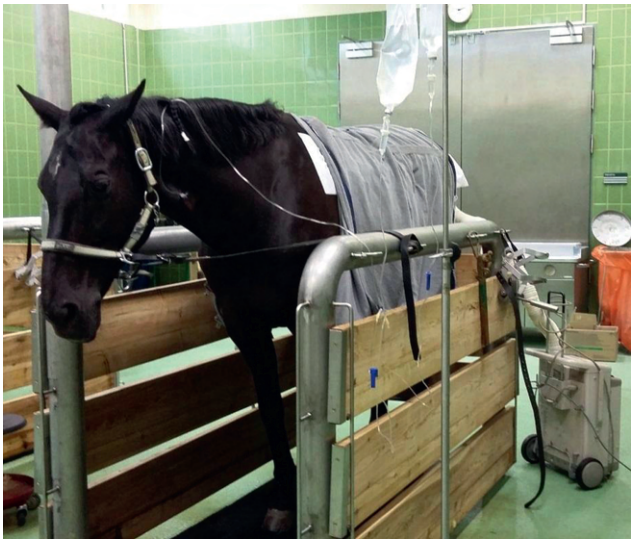

Fig 1: A horse wearing the warming blanket fixed with a stall blanket shown from the front.

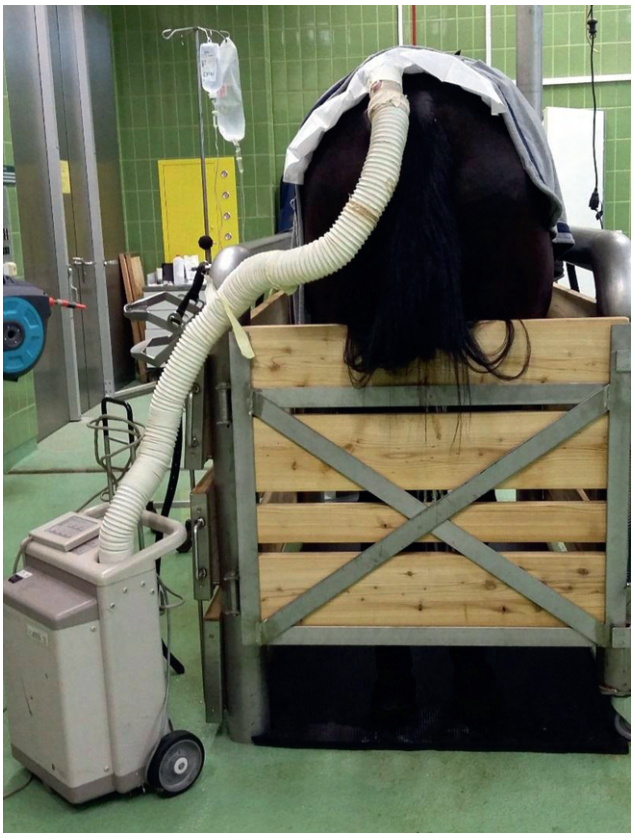

Fig 2: A horse wearing the warming blanket fixed with a stall blanket shown from the rear.

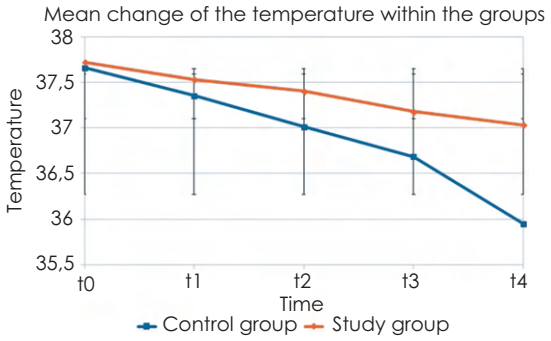

Fig 3: Mean temperature for each time point in two groups as well as s.d. are shown.

Discussion

This study is, to the best of the authors' knowledge, the first trial to effectively use an air warming blanket designed for human medicine in sedated horses and proves that it can minimise heat loss. Sedated horses are in danger of hypothermia which occurs due to decreased heat production and impaired temperature perception, especially during long procedures. As all sedative protocols

TABLE 1: Temperature measurement (°C) for each time point: T0-T4 for every horse: 1-10 in treatment and control group. Last verse for each group is the mean temperature for each time point with standard deviation calculation. Marked verse shows P value after comparison the individuals in both groups at each time point

No- horse\ Time point	T0	T1	T2	T3	T4
Study group					
1	38.5	38.4	38.4	38.1	37.9
2	37.7	37.6	37.5	37.3	37.0
3	37.6	37.4	37.2	37.1	37.1
4	37.9	37.6	37.6	37.7	
5	37.5	37.3	37.0	36.3	36.1
6	37.5	37.0	37.0	36.8	36.6
7	37.2	37.0	36.5	36.5	
8	37.7	37.7	37.5	37.1	
9	37.9	37.8	37.8	37.6	37.5
10	37.4	37.4	37.3	37.2	37.1
Mean temperature	37.7 ± 0.36	37.5 ± 0.41	37.4 ± 0.52	37.2 ± 0.55	37.0 ± 0.58
Control group					
1	37.8	37.6	37.3	37.4	
2	37.9	37.9	37.8	37.5	37.4
3	37.6	37.0	36.8	36.4	36.1
4	37.4	37.2	36.8	36.6	36.6
5	38.0	37.6	37.1	36.8	36.6
6	37.2	37.1	36.9	36.5	35.8
7	37.5	36.0	36.4	36.0	35.7
8	37.9	37.5	37.0	36.5	36.3
9	37.5	37.0	36.7	36.3	35.9
10	37.7	37.1	36.5	35.8	35.8
Mean temperature	37.7 ± 0.25	37.2 ± 0.52	36.9 ± 0.40	36.6 ± 0.54	36.2 ± 0.55
P value	0.78	0.14	0.04	0.03	0.01

for adult horses are based on the use of alpha-2 agonists, their influence on thermoregulation was examined in other species showing their effect on the central nervous system and direct influence on regulation of heat production (Szreder 1993; Kendall *et al.* 2010; Madden *et al.* 2013). BCT lower than 36°C triples the rate of SSI in human surgery (Kurz 2008). No horses in our treatment group crossed this threshold. The current study does present some limitations. Duration of the procedure was not equally long for all patients. In the treatment group, three horses' procedures lasted only 3 h making it impossible to disprove that the temperature would not fall below 36°C if the procedure was continued for 1 h longer. However, the last temperature measurement was high enough that even accounting for the mean heat loss between third and fourth hour of the procedure, BCT was unlikely to decrease below 36°C. Another limitation of the study is the relatively low number of cases and lack of case follow-up and comparison of the groups for development of post-procedural complications and treatment costs. Nevertheless, the use of an active air warming device in sedated equine cases is easy and it has a positive influence on the owners. All owners in our study displayed positive attitudes and expressed the feeling that their horse was well cared for; this may also be connected with their personal experiences as one of the most common complaints in post-operative wards in hospitals is being cold and shivering. In this study, the statistically significant effect of the warming blanket on decreasing heat loss began during the second hour of the procedure and lasted the entire length of the procedure. It was previously published in human medicine that passive warming-blankets are not effective and in order to avoid and treat hypothermia active warming strategies are needed (Bennett *et al.* 1994). That is why control horses were not covered with a stable blanket during the procedure. Dental cases were chosen for the study as they are often presented in our clinic and time of procedure was the easiest to estimate.

In conclusion, the use of an active air warming blanket in horses is an easy method to decrease the heat loss in horses undergoing long-standing sedation procedures. Further studies are needed to evaluate the influence of hypothermia on complication rates and treatment costs.

Authors' declaration of interests

No conflicts of interest have been declared.

Ethical animal research

Not applicable.

Source of funding

None.

Authorship

A. Florczyk contributed to study design, study execution, and data analysis and interpretation. H. Simhofer contributed to study design. J. Rosser contributed to study design, and data analysis and interpretation. All authors contributed to preparation of the manuscript and gave their final approval of the manuscript.

Manufacturers' addresses

[1]Equidor, Richter Pharma, Muuria, Finland.
[2]Alvagesic, Alvetra u. Werfft GmbH, Vienna, Austria.
[3]Vetifundin 5 Salzkammergut Kl., Bad Ischl, Austria.
[4]Mepinaest purum 2%, Gebro Pharma GmbH, Fieberbrunn, Austria.

References

Adderley, C.S. (2015) *The use of an intraoperative forced air warming device alone versus warmed intravenous fluid infusion and forced air warming versus warmed intravenous fluid alone in patients undergoing open intra-abdominal surgery*. The University of Southern Mississippi.

Bennett, J., Ramachandra, V., Webster, J. and Carli, F. (1994) Prevention of hypothermia during hip surgery: effect of passive compared with active skin surface warming. *Br. J. Anaesth.* **73**, 180-183.

Frank, S.M. (2001) Consequences of hypothermia. *Curr. Anaesth. Crit. Care* **12**, 79-86.

Janicki, P.K., Stoica, C., Chapman, W.C., Wright, J.K., Walker, G., Pai, R., Walia, A., Pretorius, M. and Pinson, C.W. (2002) Water warming garment versus forced air warming system in prevention of intraoperative hypothermia during liver transplantation: a randomized controlled trial. *BMC Anesthesiol.* **2**, 7.

Kendall, A., Mosley, C. and Bröjer, J. (2010) Tachypnea and antipyresis in febrile horses after sedation with α2-agonists. *J. Vet. Intern. Med.* **24**, 1008-1011.

Kurz, A. (2008) Thermal care in the perioperative period. *Best Pract. Res. Clin. Anaesthesiol.* **22**, 39-62.

Madden, C.J., Tupone, D., Cano, G. and Morrison, S.F. (2013) α2 Adrenergic receptor-mediated inhibition of thermogenesis. *J. Neurosci.* **33**, 2017-2028.

Mayerhofer, I., Scherzer, S., Gabler, C. and van den Hoven, R. (2005) Hypothermia in horses induced by general anaesthesia and limiting measures. *Equine Vet. Educ.* **17**, 53-56.

Moola, S. and Lockwood, C. (2011) Effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment. *Int. J. Evid. Based Healthc.* **9**, 337-345.

Pietsch, A.P., Lindenblatt, N. and Klar, E. (2007) Perioperative hypothermia. *Der Anästhesist.* **56**, 936-939.

Szreder, Z. (1993) Comparison between thermoregulatory effects mediated by α1-and α2-adrenoceptors in normothermic and febrile rabbits. *Gen. Pharmacol.* **24**, 929-941.

Tomasic, M. and Nann, L.E. (1999) Comparison of peripheral and core temperatures in anesthetized horses. *Am. J. Vet. Res.* **60**, 648-651.

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Original Article

Ultrasonographic guided block of the tibial nerve

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Keywords: horse; ultrasonographic guided injection; diagnostic analgesia

Summary

Tibial nerve anaesthesia is often utilised in the diagnostic evaluation of hindlimb lameness, but effective analgesia is sometimes difficult to achieve using a blind injection. The objectives of this paper are to describe the ultrasonographic anatomy of the caudomedial aspect of the superficial caudal crural compartment containing the tibial nerve and to describe a technique to perform an ultrasonographic guided block of this nerve. The tibial nerve is imaged by the use of a microconvex probe on a transverse section of the caudomedial part of the crus made approximately 8–10 cm proximal to the point of the hock. The needle is first inserted caudally to the probe, through the superficial caudal crural fascia, directed to the caudal aspect of the nerve where half of the volume of anaesthetic solution is injected (5–8 mL). A second injection is made similarly, cranial to the probe. Ultrasonographic guided injection of the tibial nerve increases accuracy of the nerve block by avoiding erroneous intravascular injections or injections under the deep caudal crural fascia that reduces diffusion of the anaesthetic solution. As deposit of anaesthetic solution can be done closer to the nerve, specificity of the block increases with quicker anaesthesia of the distal part of the limb. In addition, a smaller volume of anaesthetic solution (10–12 mL) can be used, thereby reducing the risk of proximal diffusion.

Introduction

Nerve blocks are routinely used in the diagnosis of lameness in horses but it is sometimes difficult to achieve optimal analgesia of the target areas when performing diagnostic anaesthesia of big nerves. Tibial nerve anaesthesia is often considered in the diagnostic evaluation of hindlimb lameness. In routine practice, this is usually performed using a conventional blind technique (Dyson 1984; Denoix 1991; Denoix and Trapprest 1992). However, the topography of the tibial nerve and its relation with the caudal root of the saphenous vein and caudal femoral vein may vary in a proximodistal direction. This may explain some difficulties and limitations of achieving effective and reliable analgesia of the middle and distal pelvic limb. A lot of peripheral nerves can be imaged with ultrasonography (Alexander and Dobson 2003; Denoix and Audigié 2011). Moreover, ultrasonography has proven to be useful in real-time guiding of needle placement during intra-articular or local injections (Denoix and Heitzmann 2005). For more than 15 years, we have used ultrasonographic identification of the tibial nerve in order to perform ultrasonographic guided injections (USGI) as close as possible to this nerve and especially to stay in the superficial caudal crural compartment, avoiding intravenous or intramuscular injections (Denoix 2018a).

The purpose of this article is to describe the ultrasonographic anatomy of the caudomedial aspect of the superficial caudal crural compartment containing the tibial nerve and the technique to perform an USGI of this nerve.

Basic anatomy

The tibial nerve is the main terminal branch of the sciatic nerve. Separation from the common fibular (peroneal) nerve can be seen macroscopically at the level of the proximal femur. These two nerves run down caudal to the femur between the caudal femoral muscles. They separate at the proximal margin of the gastrocnemius muscle where the tibial nerve penetrates between the two heads of this muscle while the common fibular nerve moves laterally, superficial to the lateral head of the gastrocnemius (Barone 2000; Denoix 2018b). The tibial nerve provides strong muscle rami to the gastrocnemius, popliteus and superficial digital flexor, as well as the lateral and medial digital flexor muscles (Barone 2000; Barone and Simoens 2010). It emerges cranial to the common calcanean tendon at the medial aspect of the crus (**Fig 1**). Here it is located in the superficial caudal crural compartment contained by the superficial and deep caudal crural fascias adjacent to the caudal root of the saphenous and caudal femoral veins (**Figs 1** and **2**). The tibial nerve divides into two plantar nerves just proximal to the point of the hock, which provide the superficial and deep sensitivity of the main part of the tarsus, metatarsus (including bones and tendons) and distal limb (fetlock, pastern and foot).

Indications for blocking the tibial nerve

A truncular anaesthesia of the tibial nerve can be considered in several situations. The academic indication is when more distal blocks (nerve blocks and/or intra-articular analgesia) have been performed and failed to improve a hindlimb lameness (Denoix and Trapprest 1992; Bassage and Ross 2003). In clinical conditions, blocking the tibial nerve may help to demonstrate that pain is arising from the tarsus (even after intrasynovial blocks of this joint) after a negative response to proximal metatarsal anaesthesia (Dabareiner *et al.* 2003). This block is particularly useful to discriminate proximal hindlimb lameness from middle and distal limb lameness. The final indication is to induce analgesia of the tarsus for performing standing surgical procedures such as joint lavage, cleaning and suturing of wounds (Denoix 1991).

Ultrasonographic appearance of the tibial nerve

On a transverse ultrasound section made 8 to 10 cm proximal to the point of the hock, the tibial nerve appears as an oval

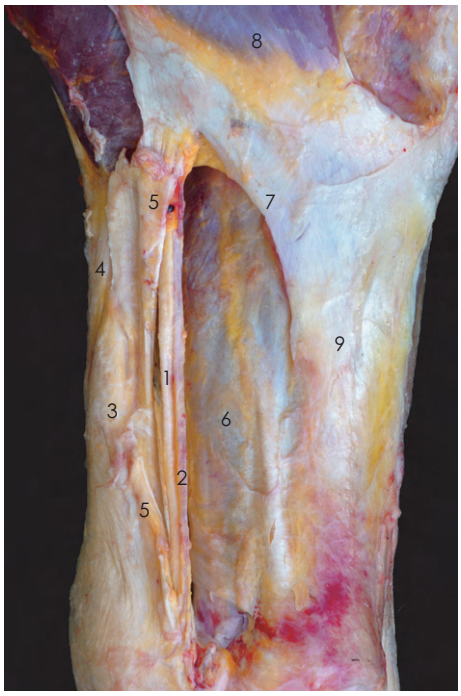

***Fig 1:** Medial aspect of the dissected crus; superficial structures. 1 = Tibial nerve; 2 = Caudal root of the saphenous vein and caudal femoral vein; 3 = Superficial digital flexor tendon; 4 = Gastrocnemius tendon; 5 = Calcanean tendon of the semitendinosus muscle; 6 = Deep caudal crural fascia covering the lateral digital flexor muscle body; 7 = Superficial caudal crural fascia connected to the semitendinosus and gracilis aponeuroses; 8 = Semitendinosus muscle; 9 = Tibia.*

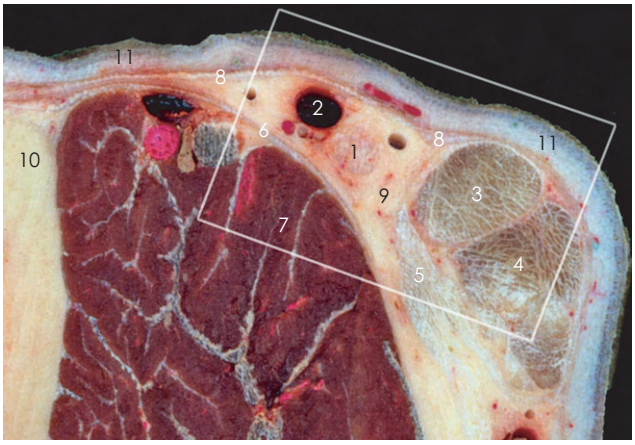

***Fig 2:** Transverse anatomical section of the caudomedial part of the crus. 1 = Tibial nerve; 2 = Caudal root of the saphenous vein and caudal femoral vein; 3 = Superficial digital flexor tendon; 4 = Gastrocnemius tendon; 5 = Calcanean tendon of the semitendinosus muscle; 6 = Deep caudal crural fascia; 7 = Lateral digital flexor muscle body; 8 = Superficial caudal crural fascia; 9 = Fat and lymphatic vessels in the superficial caudal crural compartment; 10 = Tibia; 11 = Skin.*

echogenic structure measuring approximately 2.5 × 6 mm in a 550 kg horse (**Figs 3** and **4**). Like other peripheral nerves, detailed ultrasound images show its fascicular architecture made of adjacent round fasciculi (Silvestri *et al.* 1995; Alexander and Dobson 2003). The nerve lies in less echogenic fat, caudal to the caudal root of the medial saphenous vein and caudal femoral vein, and cranial to the superficial digital flexor tendon contributing to the common calcanean tendon. It lies superficial to the deep caudal crural fascia covering the lateral digital flexor muscle body. If the probe is moved distally, the bifurcation of the tibial nerve into the two plantar nerves can be imaged.

Equipment and preparation

The basic equipment to perform an USGI of the tibial nerve includes a 15 mm 25-gauge needle and a 6–10 MHz microconvex probe. The use of an epijet (Venipuncture Set) may help avoiding repositioning of the needle if the horse moves (**Figs 5** and **6**).

If too long, the hair is clipped one hand width proximally to the point of the hock at the craniomedial aspect of the crus. The skin is prepared aseptically. A sterile glove is placed over the microconvex probe.

Horse restraint and positioning of operators

A twitch is placed on the upper lip of the horse and the thoracic limb on the side of the injected pelvic limb is held up. Both the guide operator and the needle operator are positioned on the opposite side of the injected limb (**Fig 5**). The probe is placed one hand width proximal to the point of the hock in a transverse direction. Contact with the skin and ultrasound beam penetration are improved using alcohol.

For injecting the caudal aspect of the tibial nerve, the guide operator images the tibial nerve from the cranial aspect of the opposite hindlimb and the needle operator is operating from the caudal aspect of this limb (**Fig 5**). The operators' positions are reversed for injecting the cranial aspect of the tibial nerve (**Fig 6**).

Ultrasonographic guided injection technique

As soon as horse restraint and operators' positioning are adequate, the tibial nerve is imaged at the cranial aspect of the common calcanean tendon and caudally to the caudal

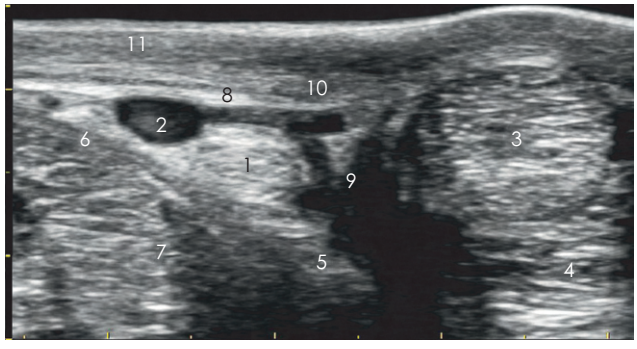

***Fig 3:** Transverse ultrasound section of the caudomedial part of the crus made with a linear probe. Cranial is to the left. 1 = Tibial nerve; 2 = Caudal root of the saphenous vein and caudal femoral vein; 3 = Superficial digital flexor tendon; 4 = Gastrocnemius tendon; 5 = Calcanean tendon of the semitendinosus muscle; 6 = Deep caudal crural fascia; 7 = Lateral digital flexor muscle body; 8 = Superficial caudal crural fascia; 9 = Fat and lymphatic vessels in the superficial caudal crural compartment; 10 = Subcutaneous connective tissue; 11 = Skin.*

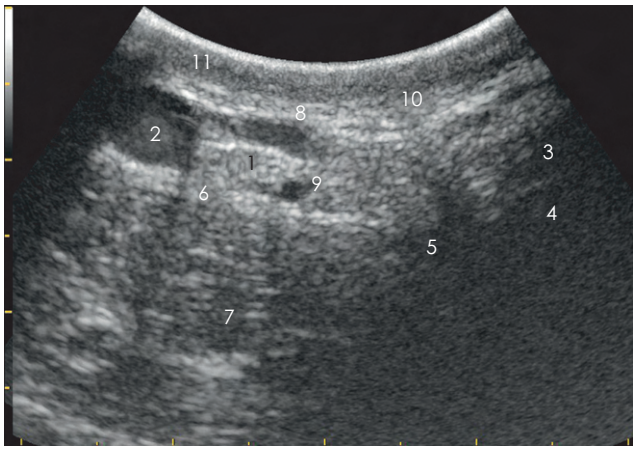

Fig 4: Transverse ultrasound section of the caudomedial part of the crus made with a microconvex probe. Cranial is to the left. 1 = Tibial nerve; 2 = Caudal root of the saphenous vein and caudal femoral vein; 3 = Superficial digital flexor tendon; 4 = Gastrocnemius tendon; 5 = Calcanean tendon of the semitendinosus muscle; 6 = Deep caudal crural fascia; 7 = Lateral digital flexor muscle body; 8 = Superficial caudal crural fascia; 9 = Fat and lymphatic vessels in the superficial caudal crural compartment; 10 = Subcutaneous connective tissue; 11 = Skin.

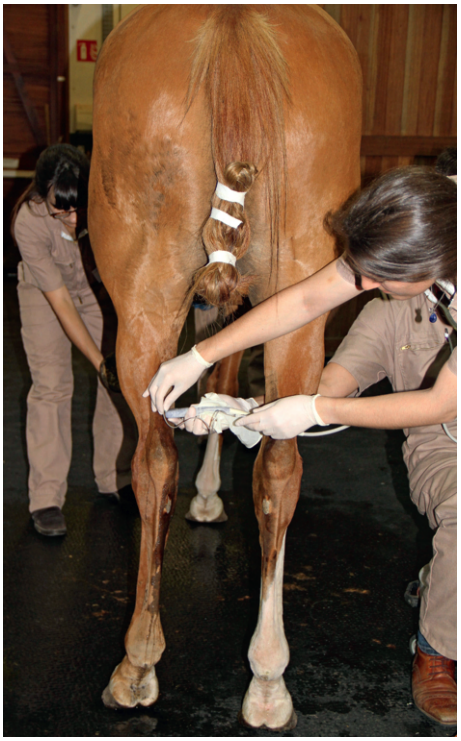

Fig 5: Positioning of the operators for injecting the tibial nerve using a caudal approach. A twitch is placed on the upper lip of the horse. The ipsilateral thoracic limb is held up. The probe operator places the probe passing cranial to the opposite pelvic limb. The needle operator is approaching the injected limb caudomedially, after careful evaluation of the horse behaviour.

root of the medial saphenous and caudal femoral veins. For injecting the caudal aspect of the nerve, the probe is moved slightly cranially to leave room for the needle placement. The

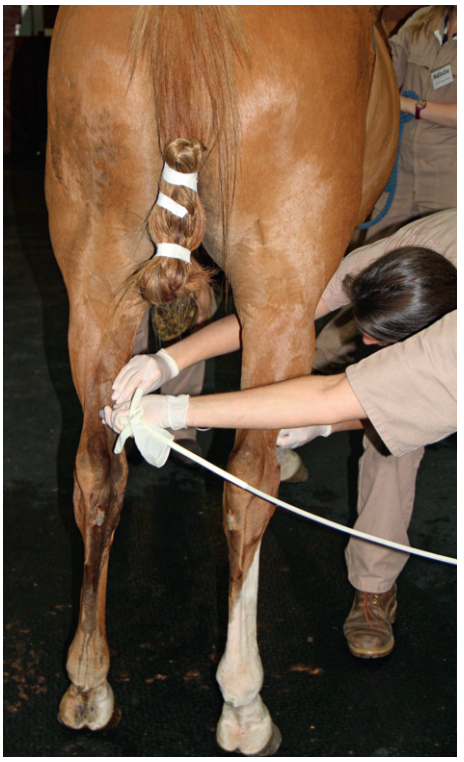

Fig 6: Positioning of the operators for injecting the tibial nerve using a cranial approach. A twitch is placed on the upper lip of the horse. The ipsilateral thoracic limb is held up. The probe operator places the probe passing caudal to the opposite pelvic limb. The needle operator is approaching the injected limb craniomedially, after careful evaluation of the horse behaviour.

needle is then inserted in the ultrasound beam and directed to the caudal aspect of the tibial nerve (**Fig 7a** and **Supplementary Item 1**). After penetrating the skin, the needle goes through the superficial caudal crural fascia and reaches the superficial caudal crural compartment. The tip of the needle is directed to the caudal aspect of the nerve and half of the volume of anaesthetic solution (5–8 mL of a 2% solution of lidocaine hydrochloride[1]) is injected, checking the distribution of the product in contact with the nerve. To achieve fast and complete anaesthesia of the tibial nerve, a second injection is made cranial to it. The probe is now placed in contact with the common calcanean tendon and the needle is inserted cranially to it in an attempt to place the tip of the needle cranially and deep to the nerve (**Fig 7b** and **Supplementary Item 2**). The second half of the product is injected (5–8 mL). Ideally, the distribution of the anaesthetic solution occurs between the nerve and the deep caudal crural fascia in order to get it completely surrounded by anaesthetic solution (**Fig 7b**). Further distribution of the solution may be seen superficial to the tibial nerve (**Fig 8**) or deep to it (**Fig 9**). Erroneous injection deep to the deep caudal crural fascia must be avoided (**Fig 10**) as diffusion of anaesthetic solution will be reduced through the fascia. Distribution of aqueous solution in the adipose connective tissue of the superficial caudal crural compartment is illustrated in **Fig 11**. In vivo distribution of diluted contrast material is shown in **Fig 12**, demonstrating lymphatic drainage and perivascular diffusion around the saphenous veins.

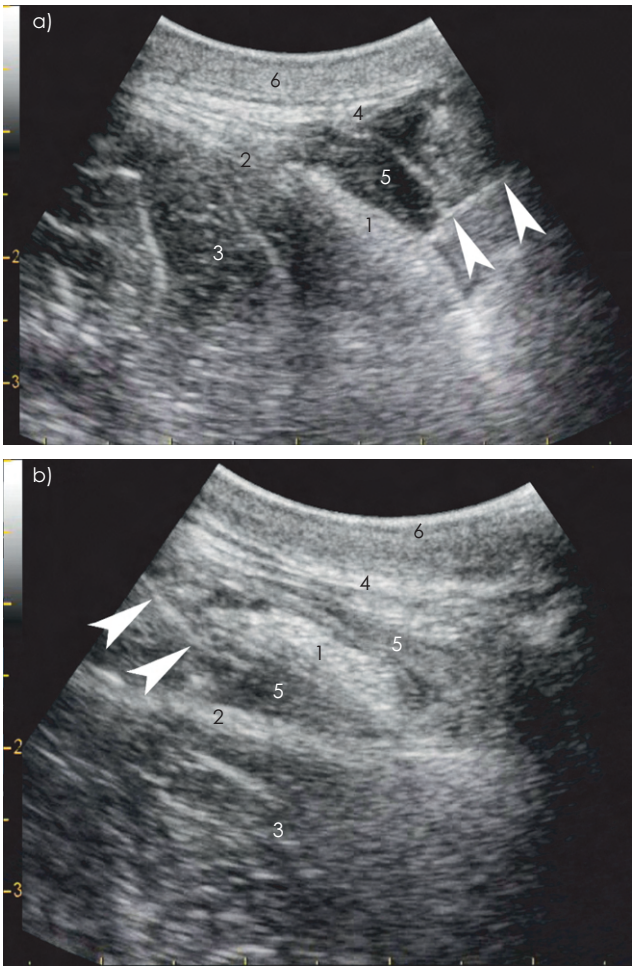

Fig 7: Ultrasonographic guided perineural injection of the tibial nerve - Transverse ultrasound sections of the caudomedial part of the crus made with a microconvex probe. Cranial is to the left. The caudal root of the saphenous vein and caudal femoral vein are collapsed by pressure on the probe. a) Caudal approach; b) Cranial approach. 1 = Tibial nerve; 2 = Deep caudal crural fascia; 3 = Lateral digital flexor muscle body; 4 = Superficial caudal crural fascia; 5 = Anaesthetic solution injected in the fat of the superficial caudal crural compartment; 6 = Skin. Arrow-heads: needle.

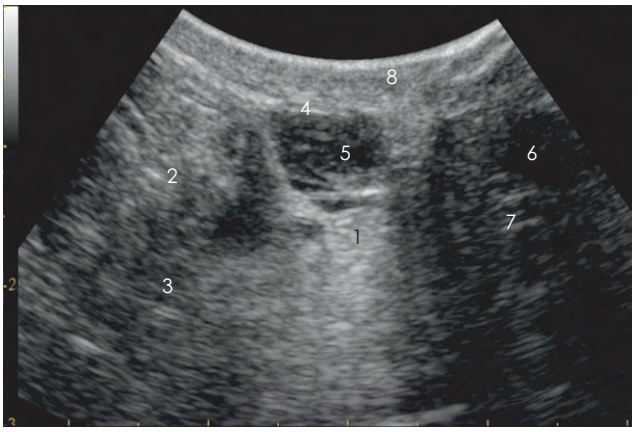

Fig 8: Ultrasonographic guided perineural injection superficial to the tibial nerve - Transverse ultrasound section of the caudomedial part of the crus made with a microconvex probe. Cranial is to the left. The caudal root of the saphenous vein and caudal femoral vein is collapsed by pressure on the probe. 1 = Tibial nerve; 2 = Deep caudal crural fascia; 3 = Lateral digital flexor muscle body; 4 = Superficial caudal crural fascia; 5 = Anaesthetic solution injected superficially to the tibial nerve in the fat of the superficial caudal crural compartment; 6 = Superficial digital flexor tendon; 7 = Gastrocnemius tendon; 8 = Skin.

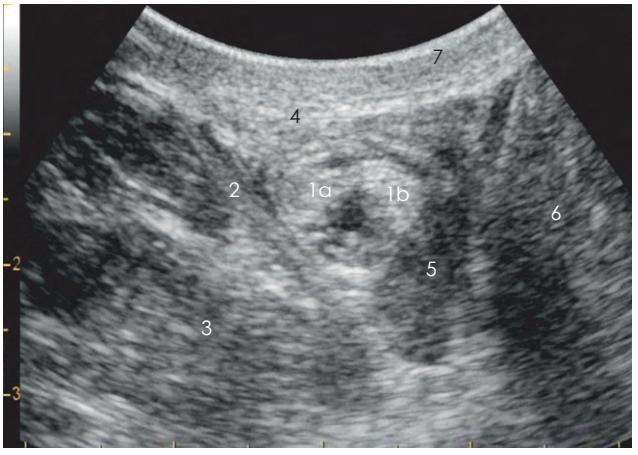

Fig 9: Ultrasonographic guided perineural injection made closer to the point of the hock. Injection is made deep to the tibial nerve and separates the origin of the plantar nerves - Transverse ultrasound section of the caudomedial part of the crus made with a microconvex probe. Cranial is to the left. The caudal root of the saphenous vein and caudal femoral vein is collapsed by pressure on the probe. 1a and 1b = Medial and lateral plantar nerves separated with anaesthetic solution; 2 = Deep caudal crural fascia; 3 = Lateral digital flexor muscle body; 4 = Superficial caudal crural fascia; 5 = Anaesthetic solution injected caudally to the plantar nerves in the fat of the superficial caudal crural compartment; 6 = Common calcanean tendon; 7 = Skin.

Five to 10 min after injection of anaesthetic solution around the tibial nerve, the skin sensation of the caudal aspect of the hock (or bulbs of the heels if no anaesthesia was performed before) is checked with a blunt instrument. Even if skin anaesthesia is not perfect (or difficult to assess, depending on the horse's behaviour), the horse is re-examined to assess any changes in lameness. Many horses improve between 5 to 10 min after the block; if the horse is not improved enough, it is rechecked at 15, 20 and 30 min (Bassage and Ross 2003).

Discussion

Operators' safety

As for any injection in the distal or middle pelvic limb in horses, operators' safety is a primary concern. The risk of being kicked is probably reduced with USGI of the tibial nerve compared to the conventional blind technique. With real-time imaging of the needle, the operators are able to control needle insertion and to direct the needle close to the tibial nerve without penetrating it. Most horses do not react even if the needle is touching the tibial nerve (extreme

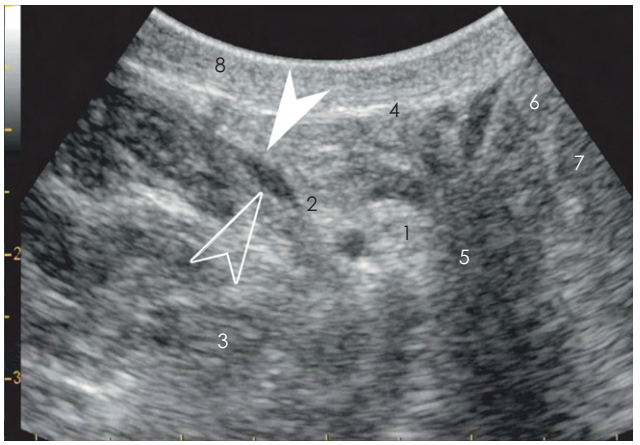

***Fig 10:** Ultrasonographic guided perineural injection of the tibial nerve - Transverse ultrasound section of the caudomedial part of the crus made with a microconvex probe. Cranial is to the left. The caudal root of the saphenous vein and caudal femoral vein is collapsed by pressure on the probe. After an inadequate caudal approach, anaesthetic solution was erroneously injected deep (open arrowhead) to the deep caudal crural fascia (arrowhead) when performing the cranial approach. 1 = Tibial nerve; 2 = Deep caudal crural fascia; 3 = Lateral digital flexor muscle body; 4 = Superficial caudal crural fascia; 5 = Anaesthetic solution previously injected in the fat of the superficial caudal crural compartment; 6 = Superficial digital flexor tendon; 7 = Gastrocnemius tendon; 8 = Skin.*

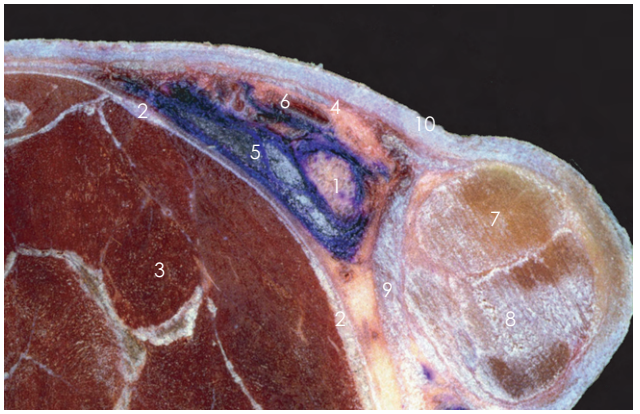

***Fig 11:** Perineural injection of the tibial nerve made with methyl violet on an isolated pelvic limb- Transverse anatomical section of the caudomedial part of the crus. Cranial is to the left. The caudal root of the saphenous vein and caudal femoral vein is collapsed. Dye solution was mainly injected deep and cranial to the tibial nerve. 1 = Tibial nerve; 2 = Deep caudal crural fascia; 3 = Lateral digital flexor muscle body; 4 = Superficial caudal crural fascia; 5 = Dye solution injected in the fat of the caudal crural compartment; 6 = Caudal root of the saphenous vein and caudal femoral vein; 7 = Superficial digital flexor tendon; 8 = Gastrocnemius tendon; 9 = Tendon of the caudal femoral muscles; 10 = Skin.*

reaction with risk of sudden fall can be seen when touching the median nerve). We have seen the needle penetrating the origin of the plantar nerves and injection separating them without inducing any horse reaction. Nevertheless, in order to avoid any risk of horse reaction (Fürst 2012), the objective is

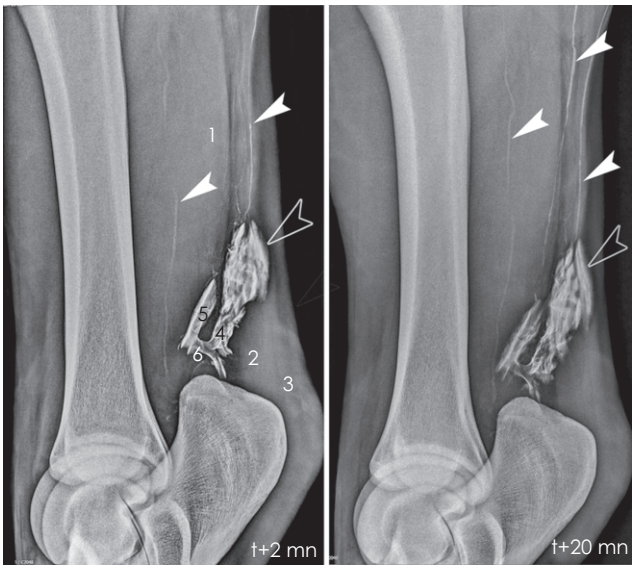

***Fig 12:** Lateromedial radiographs of the crus after ultrasonographic guided injection of a total volume of 10 mL of diluted contrast material cranially and caudally to the tibial nerve (open arrowhead). The left radiograph was taken 2 min after injection; the right one was performed 20 mn after injection. Note the proximal diffusion of contrast material in the lymphatic vessels (arrowheads) and the perivascular diffusion around the lateral saphenous vein. 1 = Lateral digital flexor muscle body; 2 = Gastrocnemius tendon; 3 = Superficial digital flexor tendon; 4 = Origin of the caudal root of the saphenous vein and caudal femoral vein; 5 = Lateral saphenous vein; 6 = Anastomosis between the saphenous veins.*

to place the needle close to the tibial nerve without touching it with the needle tip.

Increased accuracy of the nerve block

Checking the deposit of anaesthetic solution in contact with the nerve significantly increases the accuracy of the block (Strakowski 2016; Faiz *et al.* 2017). The most common mistakes, such as injecting in the body of the lateral digital flexor muscle or intravenously in the caudal root of the saphenous and caudal femoral veins (Denoix 1995), can be avoided. In addition, limitations such as inaccurate placement of the needle (Dyson 1984) or anatomical variations (Denoix 1995) can be identified by USGI of the tibial nerve.

Response to the block

With USGI the anaesthetic solution can be injected close to the nerve, therefore the use of this technique to block the tibial nerve saves time for evaluating the horse's response as anaesthesia of distal limb is achieved rapidly. In most cases the time duration to block distal pain is reduced, therefore the specificity of the block increases as the risk of analgesia of most proximal regions through proximal neurovascular diffusion or lymphatic drainage (Denoix and Trapprest 1992) is limited. In addition, the use of a smaller injection volume reduces the risk of cross reactions as complete anaesthesia of the tibial nerve can be obtained with 10–16 mL of anaesthetic solution. In many papers (Dyson 1984; Denoix 1995; Dabareiner *et al.* 2003) it is advised to block simultaneously the fibular nerves to get a complete analgesia of the distal parts of the pelvic limb (tarsus, metatarsus, digital areas). This should be done if pain is

suspected at the dorsal aspect of the tarsus and metatarsus (e.g. dorsolateral osteoarthropathy of the tarsometatarsal joint, distal enthesopathy of the tibialis cranialis or peroneus tertius muscles). Since we have used the USGI technique described in this paper, we have observed that most of the lesions affecting the proximal or distal tarsus and plantar metatarsus respond to tibial nerve anaesthesia alone.

Authors' declaration of interests

No conflicts of interest have been declared.

Ethical animal research

Not applicable to this article.

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None.

Authorship

The study design was made by J.-M. Denoix. The study execution and image acquisition were made by all authors. J.-M. Denoix and A. Beaumont prepared the manuscript. All authors gave their final approval of the manuscript.

Manufacturers' address

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References

Alexander, K. and Dobson, H. (2003) Ultrasonography of peripheral nerves in the normal adult horse. *Vet. Radiol. Ultrasound.* **44**, 456-464.

Barone, R. (2000) *Anatomie comparée des Mammifères domestiques*, Tome second. Arthrologie et Myologie. Ed: R. Barone, Editions Vigot, Paris. pp 927-953.

Barone, R. and Simoens, P. (2010) *Anatomie comparée des mammifères domestiques*, Tome 7th Neurologie II, Ed: R. Barone, Editions Vigot, Paris. pp 274-295.

Bassage, L.H.II and Ross, M.W. (2003) Diagnostic analgesia. In: *Diagnosis and Management of Lameness in the Horse*. Eds: S.J. Dyson, M.W. Ross, Elsevier, St Louis. pp 93-123.

Dabareiner, R.M., Kent Carter, G.M. and Dyson, S.J. (2003) The tarsus. In: *Diagnosis and Management of Lameness in the Horse*. Eds: S.J. Dyson, M.W. Ross, Elsevier, St Louis. pp 440-441.

Denoix, J-M. (1991) Anesthésies sémiologiques des régions proximales des membres chez le cheval. In: *Proceedings of 2nd the International Congress of Equine Medicine and Surgery*, Geneva (Switzerland). pp 12-22.

Denoix, J.-M. (1995) Anesthésie sémiologique nerveuse jambière chez le cheval. *Rec. Med. Vet.* **171**, 757-765.

Denoix, J.-M. (2018a) Diagnostic analgesia of equine hock conditions. In: *Proceedings of the 7th ISELP module: Hock and Crus, Hagyard Equine Medical institute*, Lexington, Kentucky. pp 31.

Denoix, J.-M. (2018b) *Essentials of Clinical Anatomy of the Equine Locomotor System*. CRC Press, Boca Raton, In Press.

Denoix, J.-M. and Audigié, F. (2011) Diagnosis of peripheral nerve injuries in horses. In: *Proceedings of the 7th MRI user meeting*, Bern (Switzerland). pp 43-51.

Denoix, J.-M. and Heitzmann, A.G. (2005) Apport des injections échoguidées pour les traitements locaux et intra-articulaires. In: *Proceedings of the Association Vétérinaire Équine Française (AVEF) Congrès*, Montpellier (France). pp 24-27.

Denoix, J.-M. and Trapprest, J. (1992) Anesthésies sémiologiques nerveuses tronculaires dans le diagnostic des boiteries chez le cheval : 2e partie. *Point Vet.* **24**, 259-273.

Dyson, S. (1984) Nerve blocks and lameness diagnosis in the horse. *Practice* **6**, 102-107.

Faiz, S.H.R., Imani, F., Rahimzadeh, P., Alebouyeh, M.R., Entezary, S.R. and Shafeinia, A. (2017) Which ultrasound-guided sciatic nerve block strategy works faster? prebifurcation or separate tibial-peroneal nerve block? a randomized clinical trial. *Anesthesiology and Pain Medicine* **7**, e57804.

Fürst, A.E. (2012) Diagnostic anesthesia. In: *Equine Surgery*. Eds: J.A. Auer, J.A. Stick. Elsevier, St Louis. pp 998-1015.

Silvestri, E., Martinoli, C., Derchi, L.E., Bertolotto, M., Chiaramondia, M. and Rosenberg, I. (1995) Echotexture of peripheral nerves: correlation between US and histologic findings and criteria to differentiate tendons. *Radiology* **197**, 291-296.

Strakowski, J.A. (2016) Ultrasound-guided peripheral nerve procedures. *Phys. Med. Reh. Clin. N.* **27**, 687-715.

Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1: Video of an ultrasonographic guided perineural injection of the tibial nerve using a caudal approach separating the two plantar nerves.

Supplementary Item 2: Video of an ultrasonographic guided perineural injection of the tibial nerve using a cranial approach after the caudal approach has been performed.

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Review Article

Equine viral arteritis (EVA): A potential trapdoor for the practicing veterinary surgeon in the United Kingdom

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Keywords: horse; stallion; viral; arteritis

Summary

Equine viral arteritis (EVA) is a notifiable disease in the UK with potentially serious consequences for horse owners and breeders. Legislation exists under 'The Equine Viral Arteritis Order 1995' to protect the UK from this contagious equine disease. The UK is at risk of introduction of EVA through importation of infected horses or semen. There is however much misunderstanding regarding the importance of EVA and occasionally misinterpretation, specifically on how to protect and manage stallions with vaccination. Issues with changing vaccine datasheet recommendations and vaccine availability have resulted in stallions being inappropriately vaccinated or vaccinations lapsing. This article is aimed at the practicing veterinary surgeon, to update them as to the current status of EVA vaccination and disease screening in horses in the UK and how to avoid some common pitfalls.

Introduction

Equine viral arteritis (EVA) is a respiratory and reproductive disease of horses caused by equine arteritis virus (EAV). The virus was first identified subsequent to an outbreak of respiratory disease and abortion on a Standardbred stud farm in Bucyrus, Ohio, USA in 1953 (Doll *et al.* 1957). The vast majority of EAV infections are subclinical, although clinical outbreaks are most importantly associated with abortion, neonatal mortality and establishment of persistent infection in stallions (Doll *et al.* 1957; Timoney *et al.* 1986; Pronost *et al.* 2010; Balasuriya *et al.* 2018).

Clinical signs of EAV infection vary greatly depending on a variety of factors including the challenge dose, route of infection and virus strain (Balasuriya *et al.* 2018). Acute infection can vary from entirely subclinical to lethal, with horses primarily demonstrating an influenza-like syndrome (Pronost *et al.* 2010; Balasuriya *et al.* 2018). Some highlighted clinical signs include dependent oedema affecting the scrotum (**Fig 1**), mammary gland, ventral trunk, and limbs; rhinitis with nasal discharge; conjunctivitis with ocular discharge, periorbital and/or supraorbital oedema (the conjunctivitis and periorbital encountered with EVA is referred to by some as 'pink eye'); pyrexia and leucopenia (Doll *et al.* 1957; Timoney and McCollum 1993; Wood *et al.* 1995; Balasuriya *et al.* 2018). The reproductive consequences of the condition are abortions in mares and persistent infections in a proportion of infected stallions. Abortions may occur between 2 and >10 months of gestation affecting 10–70% of mares without premonitory signs (Doll *et al.* 1957; Cole *et al.* 1986; Timoney and McCollum 1993; Balasuriya *et al.* 2018). Carrier status exists in 30–60% of stallions that are infected (Timoney *et al.* 1986, 1987; Neu *et al.* 1988); no carrier status exists in mares, geldings and prepubertal colts (Timoney and McCollum 1993) as the carrier state is testosterone-dependent. Surgical castration results in elimination of the virus (Little *et al.* 1991). It is the persistence of virus in the accessory sex glands of the entire stallion and shedding of EAV in semen that is responsible for its persistence in the horse population and allows its potential widespread dissemination across international boundaries.

Prevalence

EAV has an almost worldwide distribution (Timoney and McCollum 1993) and outbreaks of the disease have been reported from countries including Switzerland, Austria, Poland, Italy, the UK, Ireland, Spain, the Netherlands, Canada, the United States and Argentina (Balasuriya *et al.* 2018). Iceland, Japan and New Zealand have declared themselves free from the virus. EAV seroprevalence varies between countries and between horses of different breeds and ages within the same country (Balasuriya *et al.* 2018), this could reflect different breed susceptibilities to EAV and/or could be a reflection of infection circulating in different populations of mares that are not mixed with other breeds due to their differing uses and/or differing attitudes about the disease in differing equestrian disciplines. These effects are perhaps best highlighted by the prevalence of infection in USA Standardbred vs. Thoroughbred horse populations, with 70–90% of Standardbreds seropositive for EVA compared to <5% of Thoroughbreds being seropositive (Timoney and McCollum 1993). Differing attitudes between different strata and/or countries have been suggested (Newton 2007) and illustrated by differences in breed-specific seroprevalence in the UK (Newton *et al.* 1999). This all results in differing risks when horses or their semen are moved or traded internationally. There are great discrepancies throughout Europe regarding the control of EVA between countries and this has significant effects on international trade (Newton 2007). In addition, the availability and use of vaccines against EVA varies between countries outside and within the European Union (EU).

UK disease outbreaks

The disease's first known entry to the UK was in 1993 introduced by an Anglo-Arabian stallion imported from Poland (Wood *et al.* 1995). Subsequent to this, the UK Government introduced legislation under the Equine Viral Arteritis Order 1995 making the disease notifiable and laying down (in Law) how cases would be investigated and managed. Since 1997, there have

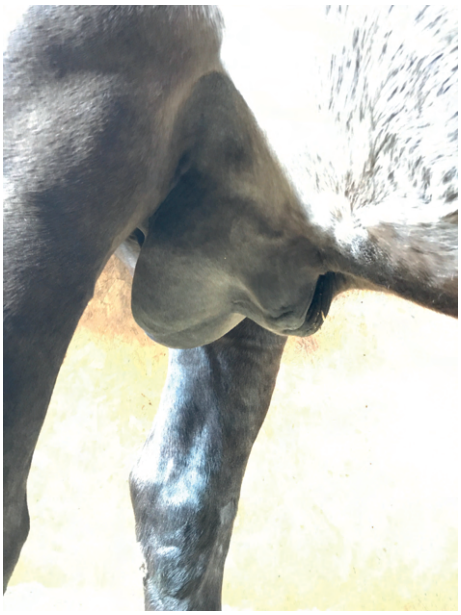


Fig 1: Dependent oedema in a 5-year-old native breed stallion's scrotum.

been four notifications by department for the environment, food and rural affairs (DEFRA) to the World Organization for Animal Health (OIE) of the detection of EAV in the UK (**Table 1**). The infection was identified in 2004 in an imported Dutch stallion whilst in quarantine (Manser and Westcott 2005), with the stallion then re-exported back to the Netherlands. The infection was then detected in 2010 in two separate stallions in Staffordshire and West Sussex, both previously imported from the Netherlands; these stallions were subsequently castrated under the Equine Viral Arteritis Order 1995. In 2012, a non-Thoroughbred Stallion in Gloucestershire was tested positive by serology on prepurchase examination and subsequently tested positive for virus in semen.

Notable international outbreaks

After the first reported outbreak in Ohio in 1953 (Doll *et al.* 1957), the next significant disease outbreak was in Standardbreds in 1977 followed in 1984 in Kentucky within the Thoroughbred breeding population (Timoney 1985). An outbreak in Pennsylvania in 1996 was precipitated by an imported Warmblood carrier stallion (Balasuriya and MacLachlan 2014). The USA then had a significant multistate occurrence in 2006 and 2007 involving American Quarter Horses (Balasuriya and MacLachlan 2014). Mainland Europe had outbreaks in France in 2007 (Pronost *et al.* 2010) and Denmark in 2008. In 2009, EVA was reported in two stallions and six mares in County Mayo, Ireland with the outbreak occurring subsequent to the importation of an infected stallion. During 2010, a significant outbreak occurred in Argentina with abortions reported in Thoroughbred mares. The mares had been mixed with some showjumping mares which had recently been inseminated with frozen semen imported from the Netherlands. From one of the semen samples, EAV was isolated despite post import virus isolation tests suggesting the semen was virus-free. In 2017, semen from an Arabian stallion imported into Argentina was detected positive to EAV during pre-import quarantine.

Notifiable disease status

Equine viral arteritis (EVA) is a notifiable disease in the UK controlled under the Equine Viral Arteritis Order 1995. Guidance on EVA from the DEFRA and the Animal and Plant Health Agency (APHA) is provided on the government website (Guidance 2014). In addition, the British Equine Veterinary Association (BEVA) provides guidance on EVA (Campbell *et al.* 2018) as well as the well-established and respected voluntary recommendations made in the 2018 edition of the Horserace Betting Levy Board (HBLB) Codes of Practice (2018). Clinical cases suspected as being EVA must, by Law, be reported to DEFRA/APHA. However, given that EVA can present in a very similar manner to other diseases, which in the UK would be far more likely, diagnosis of EAV infection is laboratory-dependent and based on virus isolation (VI), detection of viral nucleic acid by polymerase chain reaction (PCR) or demonstration of an antibody response. With the knowledge of the potential for importation of EVA however, clinicians should remain vigilant and EVA should remain a differential diagnosis until it can be ruled out by diagnostic testing of clinical cases. To the authors'

TABLE 1: Details of the four notifications of Equine Viral Arteritis (EVA) confirmed in the UK and notified by Defra to the OIE since 1997

Year	Date started*	Date reported†	Date resolved‡	Location	Details
2004	18/10/04	27/1/05	27/1/05	Gazeley, Suffolk	Subclinical semen infection in imported 5 yo Friesian stallion from the Netherlands, held in pre-export quarantine (PEQ)
2010	10/6/10	2/8/10	19/11/10	Stoke-on-Trent, Staffs	Subclinical semen infection in imported stallion from the Netherlands, screened VN positive before entry onto a stud using artificial insemination
2010	15/9/10	9/12/10	2/2/11	E. Grinstead, W. Sussex	Subclinical semen infection in previously imported (November 2009) stallion from the Netherlands, screened VN positive
2012	20/8/12	4/10/12	21/12/12	Cheltenham, Glos.	Subclinical semen infection in imported (April 2012) stallion, screened VN positive at prepurchase examination (August 2012)

*'Date started' refers to the date of the serological blood tests that triggered suspicion of a problem with each of these stallions.
†'Date reported' is the date reported to the OIE on the basis of a positive virus isolation test result for EAV in semen conducted by APHA Weybridge.
‡'Date resolved' is the date that DEFRA considered the outbreak resolved – this was on the basis of re-export of the animal back to country of origin in 2005 and 6 weeks after the animals were gelded for the other three incidents.

knowledge, the four confirmed EAV infections detected in the UK since 1997 (**Table 1**) have all been subclinical semen shedding carrier stallions first detected by routine serological testing conducted for either international trade, prepurchase or prebreeding purposes and were not identified through investigation of clinical disease.

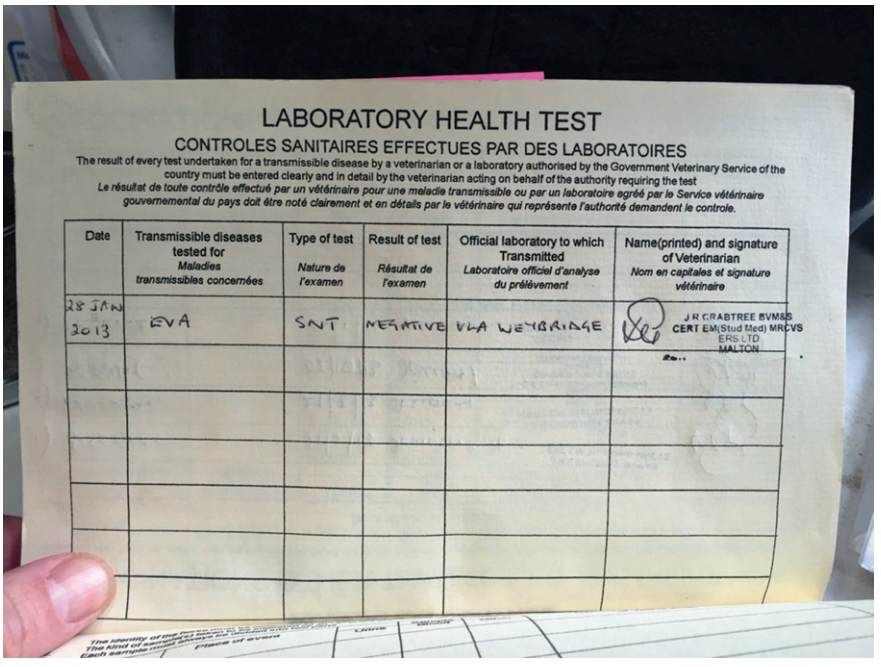
The 2018 HBLB Codes of Practice suggest reporting is necessary if disease is suspected on the basis of clinical signs or following blood testing in a mare that has been naturally mated or artificially inseminated within the last 14 days or if disease is suspected in a stallion, either on the basis of clinical signs or following blood or semen testing (discussed below).

Control of EVA

Protection against EVA in susceptible horse populations is via exclusion of the disease, preventing the dissemination of EAV in breeding populations, minimising the risk of abortion outbreaks, deaths in young foals and establishment of the carrier state in colts and stallions (Timoney and McCollum 1993). Targeted vaccination strategies protect stallions and sexually immature colts from infection. The notifiable disease status of EVA in the UK and the Equine Viral Arteritis Order 1995, means that there are mechanisms in place to deal with suspected disease occurrence.

In the UK, the HBLB Code of Practice for EVA recommends that breeding stallions are vaccinated against the disease. Only one vaccine (whole virus inactivated), Equip Artervac[1] is licensed for use in stallions in the UK and certain other European countries, including Denmark, France, Germany, Ireland and Sweden. Modified live virus vaccines available in the USA are not licensed for use in the UK as concerns remain as to the safety of such vaccines in pregnant mares late in gestation, inducing vaccine-related clinical disease, and the possibility of collateral transmission (Barquero *et al.* 2007; Newton 2007).

Following vaccination, stallions may become serologically positive by the OIE recognised virus neutralisation (VN) test, which is also referred to as a serum neutralisation test (SNT) for anti-EAV antibodies. As there is currently no ability to differentiate antibodies derived from vaccination from those produced after natural infection, it is essential to demonstrate that a horse was serologically negative prior to vaccination and that the post vaccination seropositive status is consistent with the history of vaccination, which has been given in accordance with the manufacturer's dosing recommendations (six-monthly for Equip Artervac[1]). This should be certified in the horse's passport under the 'health tests' section and acts as a permanent record for the future (**Fig 2**); if not this can lead to potentially expensive consequences. It should be noted that some older stallions' passports may not have included a health tests section and so these results may be recorded elsewhere. Despite this advice, many stallions' passports do not contain prevaccination results (**Fig 3**). Although naturally infected carrier stallions will be seropositive and may have significantly elevated antibody titres compared to some vaccinated stallions, differentiation based solely on antibody levels in seropositive animals is not reliable. Therefore, serology alone cannot be relied upon to confirm freedom from EAV infection, where vaccination has lapsed or is not in line with datasheet recommendations. In instances where this needs to be determined, analysis of semen for presence of virus needs to be performed and detection of EAV performed by either VI in cell culture or reverse-transcription PCR assay (OIE World Organization for Animal Health 2013). As quantitative PCR (qPCR) assays benefit from both very high sensitivity and rapid turnaround, it may be indicated to screen semen samples by qPCR and only to perform VI on those samples returning borderline or positive qPCR results.



LABORATORY HEALTH TEST

CONTROLES SANITAIRES EFFECTUES PAR DES LABORATOIRES

The result of every test undertaken for a transmissible disease by a veterinarian or a laboratory authorised by the Government Veterinary Service of the country must be entered clearly and in detail by the veterinarian acting on behalf of the authority requiring the test

Le résultat de toute contrôle effectué par un vétérinaire pour une maladie transmissible ou par un laboratoire agréé par le Service vétérinaire gouvernemental du pays doit être noté clairement et en détails par le vétérinaire qui représente l'authorité demandent le controle.

Date	Transmissible diseases tested for *Maladies transmissibles concernées*	Type of test *Nature de l'examen*	Result of test *Résultat de l'examen*	Official laboratory to which Transmitted *Laboratoire officiel d'analyse du prélèvement*	Name(printed) and signature of Veterinarian *Nom en capitales et signature vétérinaire*
28 JAN 2013	EVA	SNT	NEGATIVE	VLA WEYBRIDGE	JR CRABTREE BVM&S CERT EM(Stud Med) MRCVS ERS LTD MALTON

Fig 2: Laboratory health test page of a stallion's passport certifying previous negative serum neutralisation test result for EVA.

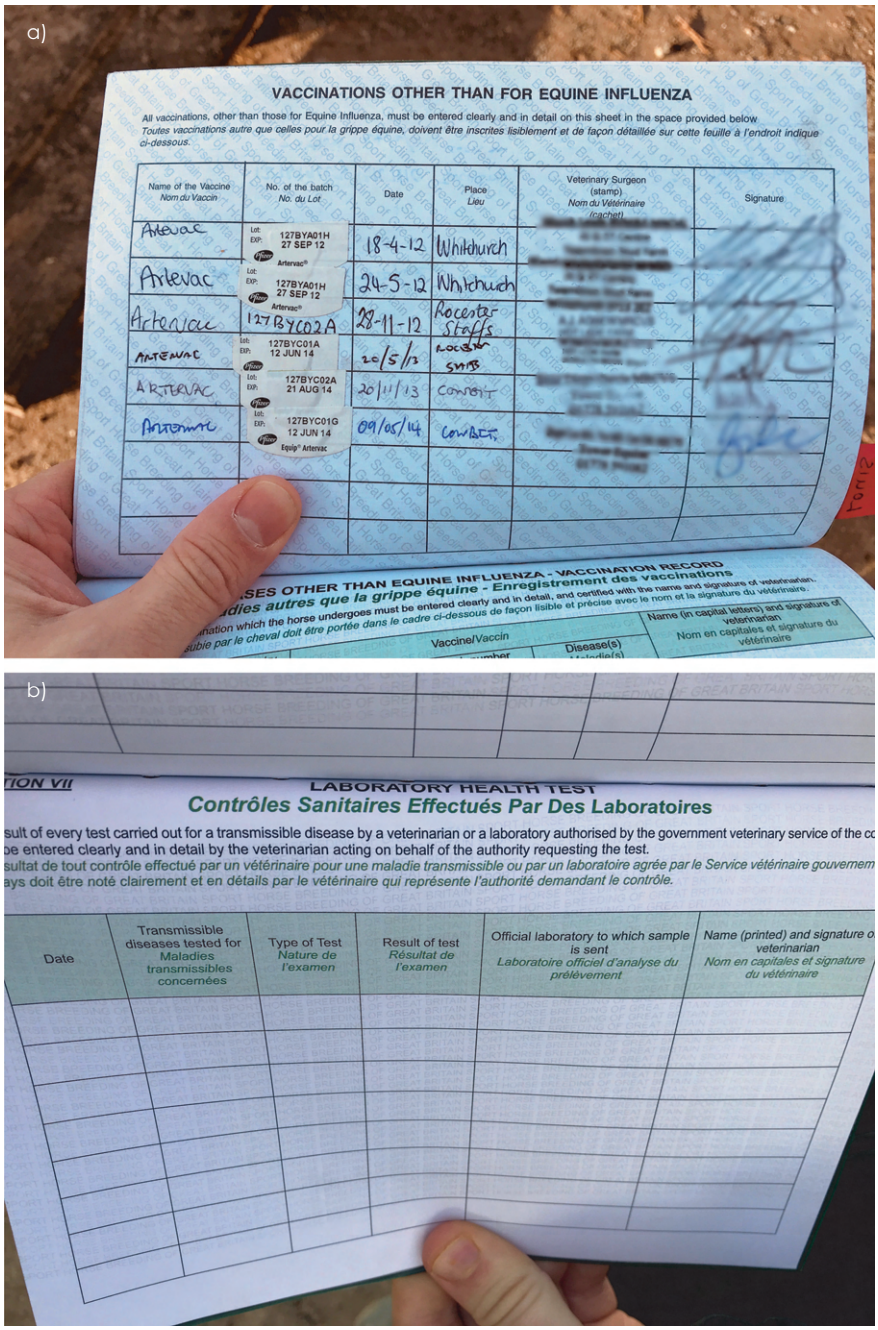


Fig 3: a) Vaccinations other than equine influenza page from a stallions passport showing previously administered Equip Artervac vaccines. b) Health tests section from the same stallions passport with no recorded prevaccination tests for EVA.

It is not an absolute requirement for stallions to be vaccinated against EVA and although there is very good uptake in Thoroughbred breeding populations the uptake in sport horse populations is lower. Factors contributing to this may include: the cost of vaccination, which requires six-monthly boosters; risk of vaccine reactions in actively competing stallions; added complications related to collection and cryopreservation of semen for international export and international travel outside of the EU for competition. Paradoxically, the latter reason may actually represent an infectious risk factor for exposing the stallion to EAV via the respiratory route. Unvaccinated stallions and mares should be screened at the beginning of each breeding season and should test negative before the onset of breeding activities in accordance with the recommendations in the HBLB Code of Practice.

Importation of horses

Importation of horses to the UK presents risks for the introduction of EVA and it is important to accept there are currently no statutory requirements for pre- or post-entry testing of horses entering the UK from EU member states. Following the UK outbreak in 1993 (Wood *et al.* 1995),

researchers at the Animal Health Trust (AHT) recommended serologically screening horses whilst still in the country of origin, prior to importation (Newton *et al.* 1999) and this still holds true in 2018. The HBLB Codes of Practice suggest serological screening of mares, in their country of origin, within 28 days of proposed importation. If a mare is positive indicating exposure to the disease she should be tested at an interval of not less than 14 days and stable or declining titres demonstrated. Immediately on arrival in the UK, she should be placed in isolation for at least 21 days; a good practice to employ regardless of the disease being considered. Serological screening for EAV should be performed on arrival and repeated at least 14 days later. If the results are seronegative, or seropositive with stable or declining antibody levels breeding activities may begin. Often it is possible to arrange for the blood samples taken in the country of origin to go to the same laboratory as in the country of destination. Increasing titres or discrepancies warrant continued isolation and further investigation.

Imported stallions should also be screened whilst in their country of origin within 28 days of proposed importation. If a stallion is seropositive, this would warrant investigation as to the vaccination or virus shedding status of the stallion prior to importation (see later). Assuming the stallion is seronegative, it is recommended that it be isolated post import and tested as described for mares.

Importation of semen

Mechanisms are in place to prevent the introduction of EVA via semen imports. All clinicians dealing with imported chilled or frozen semen should be familiar with the EU intra community trade certificates as an original certificate should accompany all semen imports from within the EU (**Fig 4**). This will be certified by an official veterinary surgeon in the country of origin to confirm that the stallion and therefore his semen is free from infections, including EAV. Semen without appropriate certification represents a significant risk. Chilled semen reaching the UK border without certification will likely pass border control agencies and be delivered to its destination into the hands of a veterinary surgeon to inseminate a mare (**Fig 5**). It is that veterinary surgeon's responsibility to notice the lack of certification, acknowledge this is an illegal import, not inseminate the semen and report appropriately. Only veterinary surgeons and certified artificial insemination technicians are allowed to inseminate mares in the UK and these technicians should also comply with these regulations. Illegally imported semen, inseminated by unqualified persons will clearly bypass all regulation. With frozen semen this is not necessarily the case, it is the importer's responsibility to check the certification but there is no requirement for this certification to follow the semen to its onward destination within the UK. It is wise, for obvious reasons that this does happen however. Frozen semen imports made without appropriate certification will be 'impounded' and if appropriate certification cannot be produced by the exporting country the semen may be re-exported or destroyed. It should be noted that DEFRA are made aware of imports, either by the exporting country or by the importer themselves and will perform random post-import certification checks with the importer. Illegal imports, however, probably do occur without DEFRA's knowledge, so the emphasis for surveillance is on the practicing veterinary surgeon.

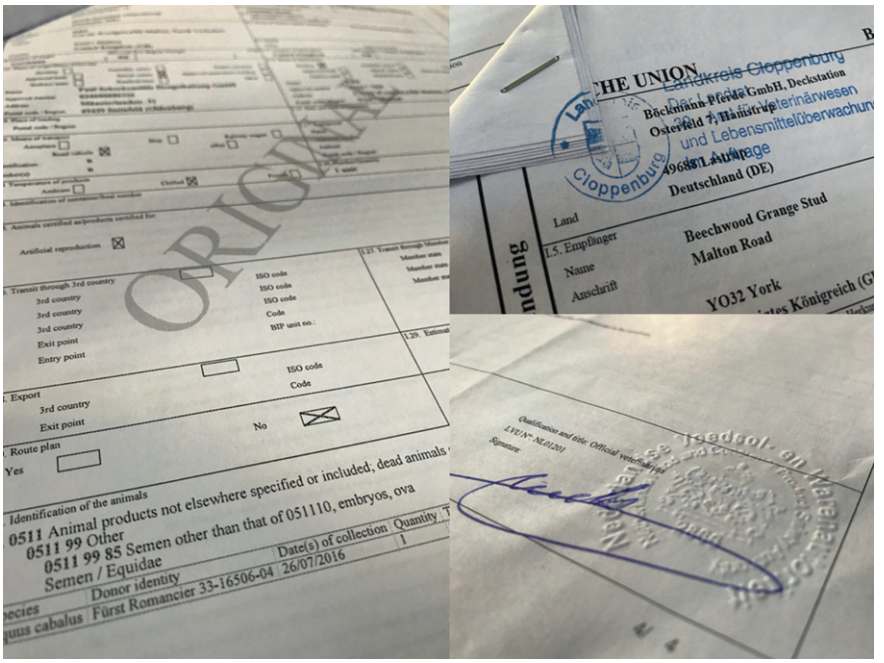


Fig 4: Elements of a valid Intra Trade Animal Health Certificate (ITAHC) a), (left) An original certificate for a given shipment of semen from a named stallion, in this case the stallion is identified as Fürst Romancier; b), (top right) The certificate is addressed to the consignee (importer), in this case Beechwood Grange Stud and 'fan-stamped' as a means to indicate that all the pages of the certificate are associated with one another; c) (bottom right) The certificate is certified by an official veterinarian in the country of origin with their signature and stamp in a colour other than black (indicating that it is not a photocopy) or as in this case with an embossed stamp.

Fig 5: Semen received from outside of the United Kingdom, without accompanying certification nor labelling of the semen sample. This represents an illegal import.

What happens if a stallion is positive on a blood test for EVA antibodies?

In the UK, many local veterinary laboratories routinely screen for EAV antibodies using a kit-based ELISA test. Any inconclusive or positive result should be subsequently referred to the APHA's Weybridge Laboratory, the Animal Health Trust (AHT) or other appropriately experienced laboratory for a VN test. If a stallion is unexpectedly found to be seropositive on serology by VN test (at a titre of 1:≥4) in the absence of any evidence of vaccination under the Equine Viral Arteritis Order 1995, this should be reported to the Divisional Veterinary Officer of the APHA. This can be done by contacting the Animal Health and Welfare Services department of the APHA (https://www.gov.uk/government/collections/notifiable-diseases-in-animals). A UK resident stallion will have a 'restriction order' placed on them restricting movement and breeding activities, which will extend to any chilled or frozen semen originating from that stallion. Then, once the seropositive status of the stallion has been confirmed by APHA, in order to ascertain whether or not EAV exists, a veterinary inspector will carry out inquiries. The likely procedure is that described in the HBLB Code of Practice with a semen sample requested from the stallion and analysed by qPCR and VI at the OIE reference laboratory at the APHA's Weybridge Laboratory. It is likely that a repeat semen analysis will be performed after 7 days. In addition, all potential contacts may be traced, isolated and sampled and all other horses on the affected premises may be screened. Once the veterinary inspector is happy the stallion and in contacts are free from EAV, as is any preserved frozen semen, restriction notices will be lifted. If a stallion is found to be positive for EAV in its semen, it is possible that if the stallion had been recently imported that it would either be re-exported or castrated to ensure the virus was eliminated and the animal could be declared EAV-free.

What happens if a mare or gelding is positive on a blood test for EVA antibodies?

If a mare or gelding is found to be seropositive (VN titre of 1:≥4, which again may confirm a positive screening ELISA result) without having previously demonstrated a positive antibody titre, there may be the possibility of recent EAV infection. The mare or gelding should be isolated and a second blood sample taken 14 days after the first and sent to the same laboratory that confirmed the first positive VN result. Stable (defined as demonstrating less than a four-fold rise between first and second samples) or declining VN antibody titres indicate that the mare or gelding is not considered likely to be infectious as this serological state is established with clearance of EAV and no carrier state is recognised in the absence of testosterone. In the author's experience, all positive mares so far encountered have originated from outside of the UK. Increasing antibody levels or clinical signs of EVA infection, especially in a mare that has been naturally mated or artificially inseminated within the last 14 days, necessitates reporting under the Equine Viral Arteritis Order 1995 to the APHA.

Problems faced by practitioners

Lapsed vaccinations

If Equip Artervac[1] vaccinations in stallions lapse (i.e. they are not boosted at six-monthly intervals as per the manufacturers recommendations), then DEFRA and international trading partners may interpret that the positive serological status of these animals at that stage may not be guaranteed to have arisen solely from vaccination and the stallion may have been exposed to EAV infection. As serology cannot differentiate infection from vaccination for the currently available vaccines, it is possible that testing of semen for presence of EAV will be necessary.

In such scenarios, it is advised that the stallion owner does not use the stallion for breeding and for the attending veterinary surgeon to make an initial risk assessment on the basis of the stallion's likely exposure to EAV. In this regard, it is important to ask the following questions:

i) Did the stallion spend time abroad during the period of lapsed vaccination?
ii) Did the stallion engage in breeding activities whilst outside of the UK?
iii) Has the stallion had close contact with mares or other stallions of unknown EAV status, be that for breeding or other reasons, within or outside the UK?

It is advised to screen low-risk stallions (i.e. returning negative answers to each of the three questions above) at the earliest opportunity for EAV in semen by PCR or VI, at the Animal Health Trust (AHT) or other appropriately experienced laboratory using a validated testing procedure. At the same time, a blood sample should be taken for VN titre testing and submitted to the same laboratory and once semen PCR results are known, vaccinations could be restarted by renewing the primary course. In low-risk situations, however, given that it is not possible to definitively demonstrate an antibody response is solely due to previous vaccination, a positive semen qPCR test result would be the reason to report the stallion to the APHA, under the Equine Viral Arteritis Order 1995.

Stallions considered at higher risk (i.e. returning positive answers to any of the three questions above) should be tested as above and re-tested again at least 7 days later. If breeding activities have occurred abroad to mares of unknown EVA status, this would constitute an even higher risk and in addition to two semen PCR tests, it is also recommended to screen at least the first two seronegative mares that are bred to these stallions for seroconversion to EAV after negative semen PCR testing. It should be stressed that if the attending clinician knows or has reasonable grounds for supposing that a stallion is infected with EAV it is their responsibility, under the Equine Viral Arteritis Order 1995, to report such a stallion to the APHA.

If a positive serology result in a stallion with lapsed vaccinations is reported to the APHA, the authorities may have no choice other than to serve notice of restrictions on the stallion and perform the testing as directed by the Equine Viral Arteritis Order 1995, whether or not those tests are ideal for the stallion or convenient for its owner.

Owners wishing to discontinue vaccination of stallions continuing to breed

Assuming the stallion resides in the UK, it is recommended that it may continue breeding activities as long as it is routinely screened for EAV in semen. A recommended minimum would be to screen at the beginning of the breeding season, prior to the onset of breeding activities. Given the stallion can have no straightforward screening test in the future, it is recommended that the stallion does not get exposure to mares or stallions that are not appropriately screened or vaccinated against EVA.

Change in datasheet recommendations for booster intervals

It is the first author's experience that there are stallions in the UK that continue to be vaccinated with annual booster intervals with Equip Artervac[1]. The current datasheet requirement for Equip Artervac[1] is for six-monthly boosters and not annually as was the case for this vaccine prior to April 2005, when the vaccine was granted a full market authorisation by the European Medicines Agency in conjunction with the UK's Veterinary Medicines Directorate. Some practitioners may have missed this change in the datasheet, whereas in some cases there was resistance from stallion owners to change what they had already been doing, although the change appeared sensible given the reported observation that first-season sires are often poorly protected after their primary course of vaccinations. Sero-surveillance of stallions vaccinated using Equip Artervac[1] conducted by the AHT demonstrated that after two boosters only 50% of stallions had protective levels of antibodies (Newton 2007). It is accepted that some older stallions may have had multiple boosters and have protective antibody levels; however, the vaccine datasheet is what the regulatory authorities refer to.

Vaccine supply issues

Recent issues with vaccine manufacture have resulted in vaccine supply gaps. The most recent resulted in there being no Equip Artervac[1] available between a batch expiry date of the 26 November 2017 and a new supply in April 2018. Zoetis, the vaccine's manufacturer made the industry aware of this expected shortage and as a result the Thoroughbred Breeders' Association advised their members to administer a booster or complete a primary vaccine course for any stallions and teasers that would be actively breeding in 2018, before the vaccine expired. Further guidance published in the 2018 HBLB Codes of Practice was aimed at demonstrating that vaccinated stallions are seropositive due to vaccination and not natural infection. The Code states:

For stallions and teasers last vaccinated in November 2017, the routine January 2018 blood sample should represent the approximate peak post vaccine antibody response from which subsequent antibody levels would follow and be able to be assessed as stable or declining. It is suggested that further samples are collected at approximately 6 month intervals thereafter (so in July 2018 and then January 2019) and in that pattern until Equip Artervac[1] is again available. When Equip Artervac[1] is again available, a final blood sample should be taken at the same time that the stallion resumes vaccination.

This was an appropriate and pro-active strategy which was only possible with forewarning of a supply issue; however, this guidance did not reach all people responsible for, or working with, stallions and it is known that there are stallions that did not get vaccinated in November 2017 which have subsequently lapsed in their vaccinations. This strategy is perhaps not so appropriate for non-Thoroughbred stallions which are shipping semen within the UK. BEVA guidance appropriately suggests that semen shipments within the UK are certified for disease including EVA. In previously vaccinated stallions, the only way to certify a stallion as free from disease, in the absence of appropriate vaccination, is to PCR screen a semen sample for EAV.

Informed consent

Informed consent is only informed if the owner understands the potential consequences of the procedure they are giving consent for. In the case of taking a blood sample for EVA serology from a stallion, the authors believe it is important to clearly highlight the potential consequences of a positive test result in light of the notifiable disease status of EVA in the UK and the potential for the stallion to have to be castrated under the Equine Viral Arteritis Order 1995. This can be no better highlighted in the prepurchase scenario where the veterinary surgeon in the UK is acting on behalf of the prospective purchaser and not the current stallion owner.

Author's declaration of interests

No conflicts of interest have been declared.

Ethical animal research

Not applicable.

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Authorship

Both authors involved in preparation and final approval of the manuscript.

Continued on page 392

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Review Article

Venographic evaluation of the circumflex vessels and lamellar circumflex junction in laminitic horses

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Keywords: horse; circumflex; lamellar circumflex junction; laminitis; venogram

Summary

Venograms provide information about areas of vascular compression or damage within the hoof. Key areas of the venogram to evaluate include the circumflex vessels, papillae and lamellar circumflex junction. This article describes and illustrates the appearance of the circumflex vessels, papillae and lamellar circumflex junction in sound and laminitic horses.

Introduction

Horses with laminitis may appear similar clinically in the early stages of laminitis yet have different outcomes due to the varying degrees of lamellar and vascular damage. Radiographically it can be difficult to make a definitive diagnosis of acute laminitis prior to demonstrable rotation of the distal phalanx (P3) and difficult to differentiate between chronic laminitis and other commonly occurring syndromes that can also have measurable capsular rotation. Venograms provide information about areas of vascular compression or damage within the hoof (Baldwin and Pollitt 2010) and offer the potential to assess soft tissue damage early in the course of laminitis (Redden 2013). The circumflex vessels and the lamellar circumflex junction play an important role in venogram evaluation. This article looks closely at the normal and pathologic variations in the appearance of those vessels and their associated papillae in both sound and laminitic horses. To illustrate the appearance of these vessels we have provided print images as well as multiple supplementary images. Supplementary images may be found in the online version of this article. Print images are referred to in the text as **Figs 1**,**2** etc., while the supplementary images are referred to in the text as **Supplementary Items 1**,**2** etc.

Performing the venogram

The venogram is performed by performing an abaxial sesamoid nerve block[1] and placing a tourniquet (2.5 cm × 50 cm strip of rubber tyre inner-tube) at the widest part of the metacarpo/tarso-phalangeal joint, secured by tape.[2] To avoid tourniquet failure, the first wrap of the tourniquet is secured as tight as possible in the dorsal direction, and the fetlock region is clipped in breeds that have feathers or a thick hair coat. Tourniquet failure is a common error for those learning the procedure. Isotonic radiopaque contrast[3] is injected into the palmar digital vein at the level of the pastern. For a 12.5 cm wide foot, two 12 mL luer-lock syringes of contrast are injected through an injection port into a 21 gauge × 19 mm butterfly catheter.[4] Gentle digital pressure over the needle and palmar digital vein, as well as monitoring ease of injection via the 12 mL syringes, and frequent back flushing of the contrast with the thumb along the plunger throughout the procedure helps prevent unwarranted perivascular injection which is a common technique error (Redden 2013; Rucker 2016). As the second syringe of contrast is injected, the carpus is gently flexed to unweight the foot and facilitate filling of the vasculature. When injection of contrast is complete, the butterfly catheter is secured by the tourniquet tape and radiographs are taken. The suggested minimum of views includes weightbearing lateromedial and dorsopalmar/plantar images, non-weightbearing lateromedial and palmar/plantar-dorsal images, and a final weightbearing lateral image. Other views such as the 65 dorsopalmar/plantar or oblique images may be helpful depending on the pathology that is being evaluated (e.g. pedal osteitis, keratoma) (Leise *et al.* 2016). **Figure 1** illustrates the appearance of a venogram and the key areas of evaluation.

Anatomy considerations

Because the tourniquet occludes the proximal vasculature, contrast injected into the palmar digital vein results in retrograde filling of the veins and arteries within the digit (Baldwin and Pollitt 2010). **Figure 2** illustrates the vascular anatomy of the digit focusing on key areas evaluated on venograms. The medial and lateral palmar digital arteries and veins enter foramina on the solar surface of the distal phalanx. Within that osseous canal, the arteries (and veins) anastomose to form a terminal arch. Multiple vessels branch from the terminal arch, travel through smaller foramina, and exit the parietal face of the distal phalanx to anastomose with the sublamellar vascular bed. The proximal aspect of the sublamellar vascular bed anastomoses with the coronary plexus, vessels which originate from the palmar digital artery and vein. The distal aspect of the sublamellar vascular bed anastomoses with the circumflex vessels (lamellar circumflex junction), which also originate from branches of the palmar digital artery and vein. Arteriovenous anastomoses are present within the sublamellar vascular bed, and also within the papillae (coronary, terminal and solar) (Pollitt 2016).

Vessels from the distal parietal branches of the terminal arch exit through foramina in distal P3 and contribute to the circumflex vessels, located peripheral and slightly distal to the

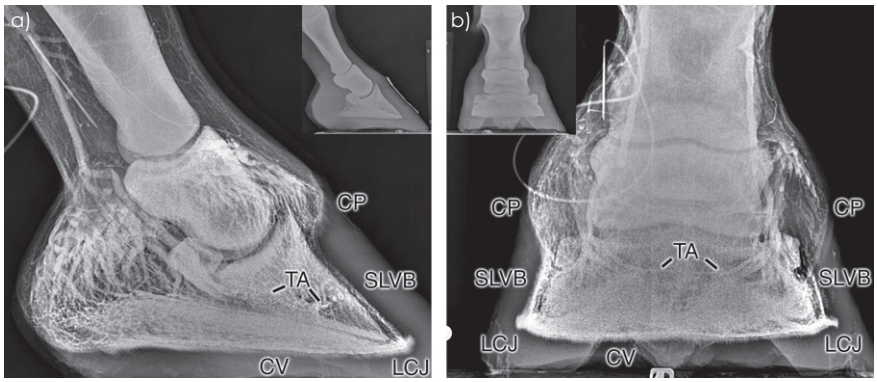

***Fig 1:** Venogram images of a sound right forefoot with a zero degree palmar angle and the lateral palmar digital vein catheterised. Lateral a) and dorsopalmar b) images are shown. Areas to evaluate include the coronary plexus (CP), sublamellar vascular bed (SLVB), terminal arch of the palmar digital arteries and veins (TA), and the focus of this article the lamellar circumflex junction (LCJ) and solar and circumflex vessels (CV). The lamellar circumflex junction mimics the angle of the apex of the distal phalanx (P3), and solar papillae are evident distal to the circumflex vessels. The circumflex and solar vessels overlap the vasculature of the heel, frog and to some extent the terminal arch. This foot has 20 mm of sole depth (measured on the lateral image from the apex of P3 to the distal margin). On this foot, the distal aspect of the solar papillae are 10 mm distal to the apex of P3.*

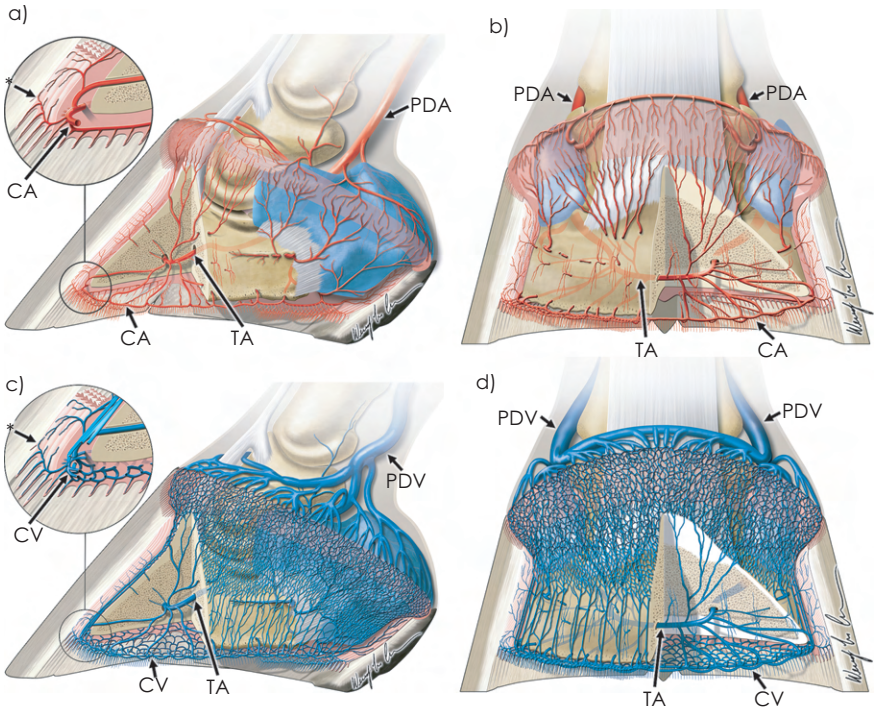

***Fig 2:** Arterial (a&b) and venous (c&d) vasculature of the foot. (Note: The vasculature of the frog and digital cushion are excluded). a) Lateromedial arterial view. The palmar digital arteries (PDA) terminate in a bony canal within the centre of the distal phalanx. The medial and lateral arteries anastomose to form the terminal arch (TA). Branches course through the bone to the parietal surface, then course distal and peripheral to the distal margin of the distal phalanx to contribute to the circumflex artery (CA). Inset: the solar papillae of the circumflex artery are parallel to the parietal face of P3. The white line originates from the terminal papillae (*). b) Dorsopalmar arterial view. The medial and lateral PDA unite to form the TA. Branches from the circumflex arteries course beneath P3 to supply the solar papillae. c) Lateromedial venous view. The palmar digital veins (PDV) drain the complex venous network of the foot. Veins are present within bony canals of the distal phalanx including the terminal arch (TA) Inset: each solar papillae has a vein that pairs the artery, including the terminal papillae (*) of the white line. The circumflex veins (CV) are distal and peripheral to the distal phalanx, and are connected to solar branches. d) Dorsopalmar venous view. Image provided by Inky Mouse Studios (www.inkymouse studios.com).*

distal rim of the distal phalanx. Peripherally these vessels unite with the distal aspect of the sublamellar vascular bed forming the lamellar circumflex junction. Axially, the solar dermis is supplied by the branches from the circumflex vessels. The solar dermis is dependent upon the circumflex vessels (with the only exceptions being the angles of the heel and the frog which

have a more caudal blood supply). Radial solar branches from the circumflex vessels curl under P3 and extend axially to supply the solar dermis. The radial solar branches and small branches from them form the solar papillae. The distal parietal branches which anastomose with the circumflex vessels form the terminal papillae (Pollitt 2016).

Areas evaluated on the venogram include the terminal arch of the palmar digital vessels (TA), the coronary plexus (CP), the sublamellar vascular bed (SLVB), the circumflex and solar vessels (with their papillae) (CV), the lamellar circumflex junction (with terminal papillae) (LCJ), and the heel vasculature (Leise *et al.* 2016; Rucker 2016) (**Fig 1**). In the pastern, the muscular-walled palmar digital arteries can be distinguished from the smooth walled palmar digital veins. With that exception, the venogram does not distinguish between arteries and veins. The overlapping vessels render distinction impossible. This article, defines the term 'vessels' to include both the arterial and venous components unless specified.

Venogram appearance of the circumflex vessels and lamellar circumflex junction

On the lateromedial image, the circumflex vessels extend from the anastomosis with the dorsal sublamellar vessels at the apex of P3 to the caudal aspect of the wings of P3. On the dorsopalmar view, the appearance of the circumflex vessels may vary somewhat depending on the palmar angle of P3 in relation to the ground. If the palmar angle of P3 is zero or negative, the circumflex and solar vessels may overlap the distal margin of P3 especially in the heel region (**Supplementary Item 1**). As the palmar angle and sole depth increases, the circumflex vessels are more easily distinguished distal and peripheral to the margin of P3. If a foot has a large cup, the vessels of the sole may be difficult to individually distinguish on the lateral and dorsopalmar images due to overlap of the distal aspect of P3.

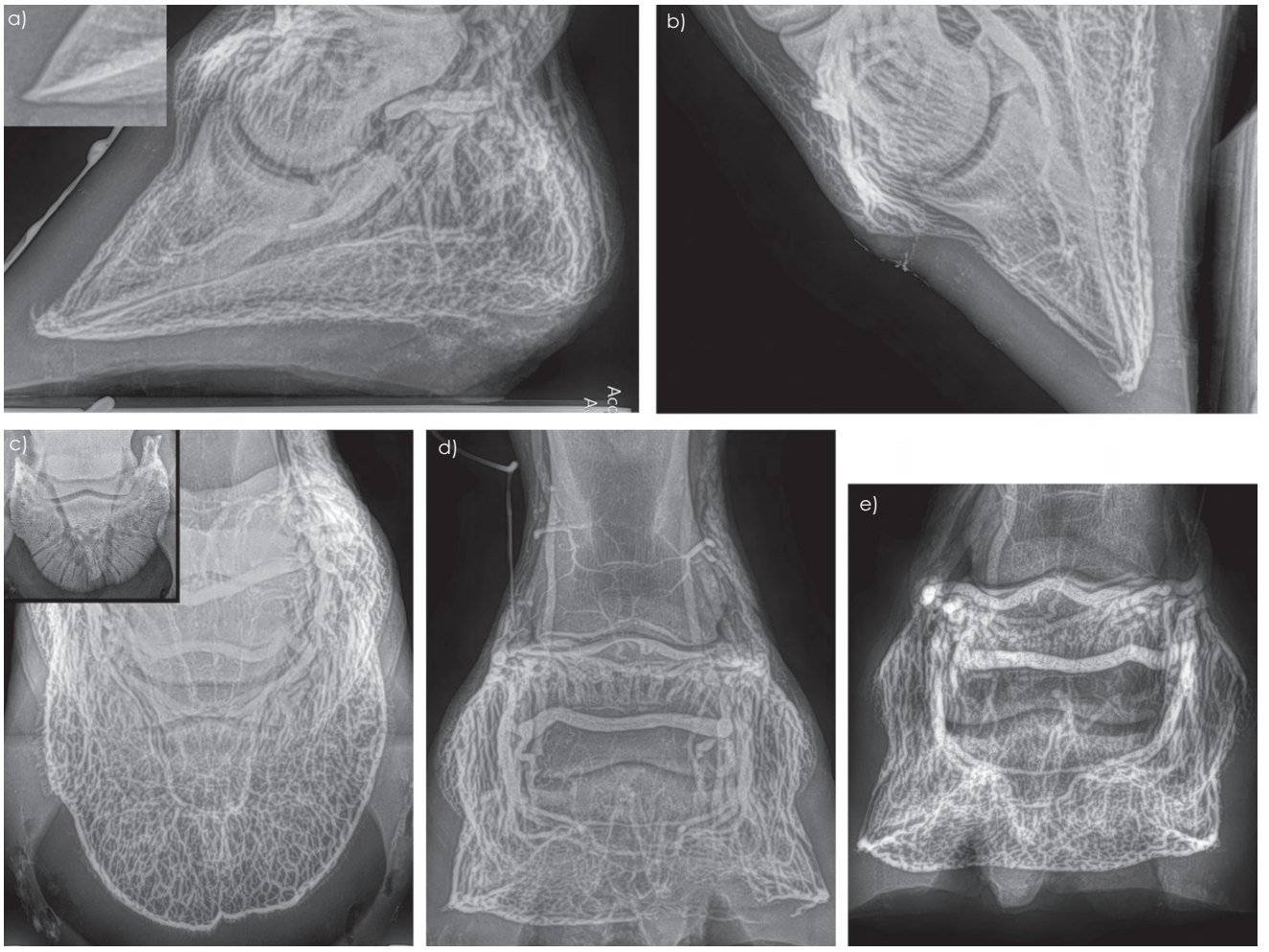

***Fig 3:** Left forefoot of sound Thoroughbred polo-pony with no history of laminitis showing variation in the appearance of the lamellar circumflex junction. Alterations of the distal margin of P3 with concurrent alterations of the lamellar circumflex junction are presumed to be secondary to use with repetitive loading/trauma. a) Inset: the distal margin of P3 is remodeled. The lamellar circumflex junction is widened and slightly irregular. The terminal papillae are not parallel to the parietal face of P3. b) Non-weightbearing lateromedial view. No change in appearance of the lamellar-circumflex junction or the circumflex and solar vessels. c) 65 degree dorsopalmar view. Inset: remodelling of the distal rim of P3 is evident. The circumflex vessels mimic the remodelled bone margin. d) Weightbearing dorsopalmar view exhibits a distinct area with reduction of contrast in the lateral circumflex and solar vessels. e) Contrast has filled the circumflex and solar vessels on the non-weightbearing palmodorsal view.*

The terminal papillae extend distal to the circumflex vessels, and the solar papillae extend distal to the branches from radial and smaller branches of the circumflex vessels as they extend across the solar surface. At the lamellar circumflex junction, the terminal papillae usually mimic the angle of the dorsal parietal face of P3.

With adequate sole depth (15–20 mm measured distal to the apex of P3 on the lateral image) the papillae may extend 3–5 mm distally, making the entire width of contrast filling in the vasculature below the palmar surface of P3 up to 10 cm (**Fig 1**, **Supplementary Item 2**). A sound foot may have considerably less sole depth, with a corresponding reduction in the depth of the vascular bed (**Supplementary Item 3**). A very thin sole (6 mm or less) may have the circumflex vessels only 3–4 mm distal to P3 with no solar papillae evident on the venogram (**Supplementary Item 3**) (Rucker 2016). At the lamellar circumflex junction, vessels usually appear as a distinct line 4–6 mm peripheral to the apex of P3 and form a similar angle to that of the parietal and palmar surfaces of P3.

The appearance of the circumflex vessels and lamellar circumflex junction in some sound horses will vary depending on the sole depth, conformation effects on load and remodelling of the distal border of P3 (**Supplementary Items 4** and **5**). These and other pathologic conditions of the foot must be taken into consideration when evaluating the circumflex and lamellar-circumflex junction appearance in venograms (**Fig 3**).

Venogram appearance of the circumflex vessels and lamellar circumflex junction in laminitis

With laminitis, the vasculature within the dermis of the sole is particularly vulnerable to compression by displacement of P3. In addition, the vascular supply to the distal rim of P3 can be compromised by compression and distortion of the distal parietal vessels as they unite to form the circumflex vessels. Venograms provide insight into the changing morphology and compression of these vessels (Baldwin and Pollitt 2010).

Before radiographically measurable displacement of the distal phalanx occurs, early laminitis pathology may be evidenced by alterations in the angle and length of the papillae of the circumflex vessels. The papillae are normally oriented parallel to the dorsal face of P3 (**Fig 1**). With early laminitis they become more horizontal, bending towards the dorsal surface of the wall and with progression of the syndrome they may shorten or disappear from the venogram (**Figs 4** and **5**, **Supplementary Item 6**). The lamellar circumflex junction, normally at a distinct linear angle corresponding to the apex of P3, begins to distort to a folded dorsal appearance (**Fig 4**, **Supplementary Item 6**). During these early stages of laminitis it is particularly helpful to compare weightbearing and unloaded images when trying to establish the diagnosis and severity of laminitis (**Figs 4–5**). In the unloaded dorsopalmar and lateral images, the distortion and displacement of the lamellar circumflex junction can be markedly reduced relative to lesion intensity. The circumflex and solar vessels may have an increase in the contrast volume (**Fig 4**) and possibly a return of papillae in their correct orientation. The improved difference in the contrast pattern between the loaded and unloaded views is a significant point of interest as it can allude to the severity of damage as well as the potential treatment prognosis.

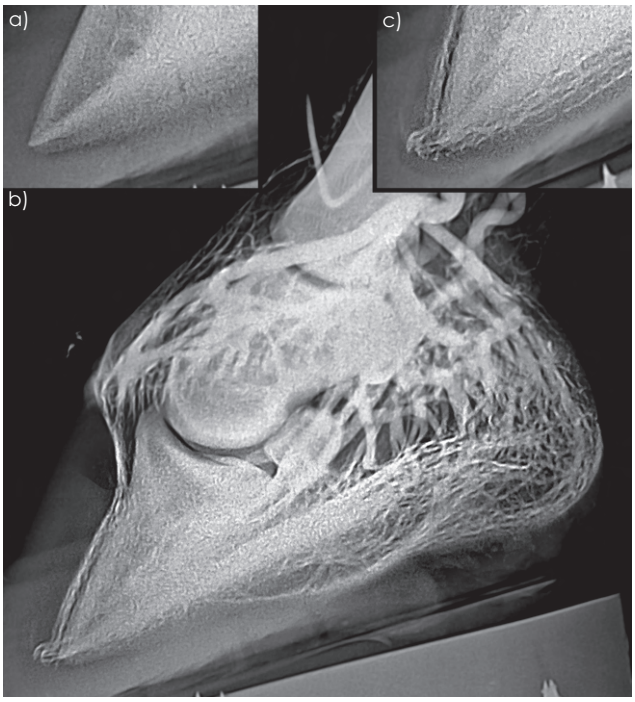

Fig 4: Five-year-old Quarter Horse with laminitis following triamcinolone joint injections. History includes triamcinolone joint injection on day 0 and 3. Clinical lameness began on Day 5 and included increased digital pulses on day 6 when he was stalled in ice boots. Wedged heel shoes were added to the boots on day 10. Radiographs and venograms were performed Day 14 and are shown in images a–c. a) The distal phalanx is parallel to the dorsal wall and has no bone remodelling. b) The lamellar circumflex junction is folded and located proximal to the apex of P3. There is no contrast in the circumflex and solar vessels distal to the anterior half of P3 when weightbearing. c) Slightly more contrast returns to the circumflex and solar vessels when not bearing weight but the lamellar circumflex junction remains folded in an abnormal location.

Horses that have a progressive reduction in contrast volume on serial venograms are thought to have a higher level of lamellar insult, resulting in compression of the vessels (reduction in contrast) (**Figs 4** and **5**) (Baldwin and Pollitt 2010; Redden 2013; Rucker 2016). With progression of the syndrome, the lamellar circumflex junction may become located adjacent to the apex of P3 with the terminal papillae located in a horizontal plane (**Figs 4** and **5**). Contrast may be reduced or absent in the circumflex and solar vessels distal to the apex of P3 (**Figs 4** and **5**, **Supplementary Items 7** and **8**).

Progressive changes may result in the lamellar circumflex junction being located proximal to the apex of P3 (**Figs 4** and **5**); this may occur without changes in radiographic soft tissue parameter measurements when comparing previous and current images (Redden 2013). The lamellar circumflex junction appears folded and, if visible, the terminal papillae are oriented in a dorsal direction, almost perpendicular to the parietal face of P3. Contrast is reduced or absent in the solar dermis and circumflex vessels, and often there is no contrast distal to the dorsal half of P3 (**Fig 5**, **Supplementary Item 8**). The reduction in contrast is not always permanent. Removing the limb from weightbearing or altering the palmar angle may restore contrast to an area.

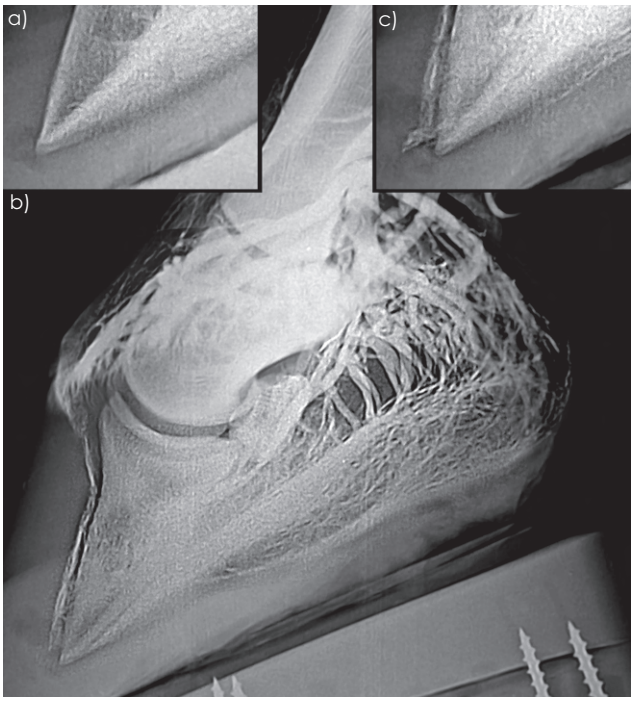

Fig 5: Horse from Figure 4. Venograms were performed on Day 23 and show progression of vascular changes from images shown in Figure 4. a) Slight alteration in the distal dorsal parietal surface of P3 is present at the level of the displaced lamellar-circumflex junction. b) The lamellar circumflex junction is no longer apparent on a weightbearing image. There is no contrast within the circumflex and solar vessels distal to the anterior half of P3. c) On the non-weight bearing image the displaced lamellar-circumflex junction is apparent, but contrast is absent in the circumflex and solar vessels.

Horses with severe laminitis and displacement of P3 develop progressively greater venographic changes noted by filling deficits on the venogram (**Figs 4** and **5**) (Baldwin and Pollitt 2010). If treatment response is favourable, serial venograms (**Figs 4-6**) may demonstrate an improvement in contrast pattern as tissue repairs (Redden 2013; Rucker 2016).

When using venograms to monitor progress or deterioration, and to guide treatment strategies, the first days to weeks of a case are considered particularly critical as this appears to be the major window of opportunity for favourable response of the soft tissue (**Supplementary Item 6**). Monitoring the influence of pathology associated compression of the vascular supply/dermis relative to chosen treatment may help determine treatment options and may help to avert bone damage (**Fig 6**) (Redden 2013; Rucker 2016). Critical venographic changes indicative of a favourable response to treatment include improved filling of the circumflex and solar vessels that are responsible for sole growth, and improved filling and orientation of the lamellar circumflex junction. In the authors' opinion, time is of the essence as vascular, soft tissue and potential bone damage is relative to the intensity and duration of nutrient deprivation. Aiding reperfusion as quickly as possible may decrease the chances of permanent bone damage to the distal rim of P3 (**Supplementary Item 6**) (Rucker 2016).

When treatment results in full recovery, the circumflex vessel filling is restored on the venogram, solar papillae again become evident and measurable increases in sole depth begin to occur (**Supplementary Item 6**, **Figs 4**–**6**). In our experience, solar papillae returning to the venogram after previous compression is associated with improved sole growth (Redden 2013; Rucker 2016).

Chronic cases that are presented with or develop prolapse of the circumflex vessels proximal to the apex subsequent to an unfavourable treatment response can

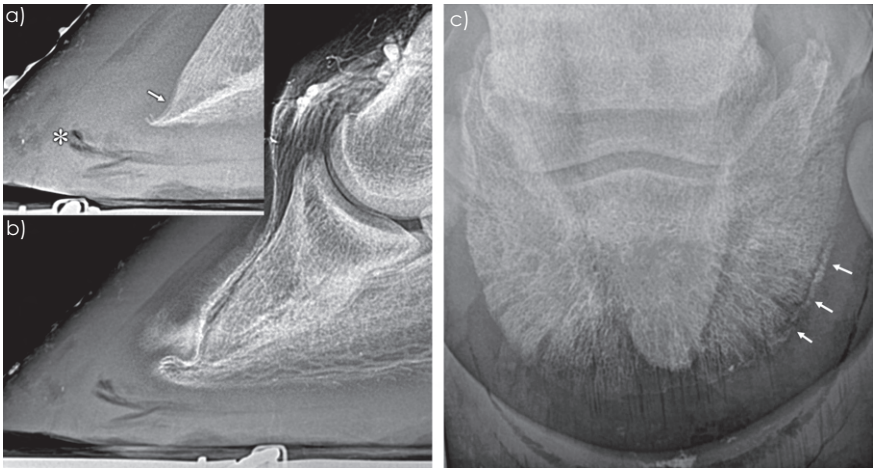

Fig 6: Horse from Figures 4 and 5. Shoeing and deep digital flexor tenotomies were performed on Day 23. A progress venogram was done on day 93 due to increased lameness and mild swelling at the coronary band. a) Inset: bone modelling of the dorsal distal parietal surface of P3 (arrow) is evident at the previous level of lamellar-circumflex junction displacement. The distal rim of P3 has also remodeled. Distal to P3, a radiolucency in the sole separates the postsurgical new growth from the older distal sole (*). a) The lateral venogram reveals that contrast has returned to the circumflex and solar vessels and is present distal to P3. The lamellar circumflex junction has remodelled around the distal rim of P3. Just proximal to the lamellar-circumflex junction, the recovering sublamellar vascular bed is not yet organised. b) 65 degree dorsopalmar view: moderate loss of the distal rim of P3 is evident centrally and laterally, including a lateral rim fracture (arrows). We hypothesise that the lameness was secondary to sepsis and bone modelling as the venogram indicated improved dermal stability with minimal compromise.

have remarkable bone erosion of the apex adjacent to the area of prolapse. The terminal papillae at the lamellar circumflex junction may continue to produce epidermis in spite of being displaced dorsally and proximal to their normal anatomical location. Over time, the new horn growth expands relative to the shape and size of the bone depression. The space occupying horn tissue may contribute to compression of the dermis and distal dorsal edge of the apex of the P3 (**Fig 6**). In the authors' opinion, the degree of osteitis at the distal margin of P3 appears related to the duration and severity of the vascular compromise (**Figs 4-6**). Bone modelling may be relatively minor involving only the apex of P3 (**Fig 6**) or could involve a more extensive amount of the distal rim (**Supplementary Item 9**). In our experience, survival and daily comfort/quality of life depend on minimal bone damage and the rapid restoration of the lamellar circumflex junction, circumflex and solar vessels with the corresponding resumption of sole growth.

Laminitis cases that do not recover fully often fall into two general categories: early extensive catastrophic displacement (as evidenced by complete void of contrast distal to the coronary band with the exception of the caudal heel), or cumulative damage with cycles of vascular compromise contributing to prolonged progressive pathology, often over the course of several years. The majority of chronic cases of laminitis can recover to various degrees of soundness with efficient pathological shoeing and appropriate medical treatment. Radiographic information is vital for the farrier as they mechanically trim and shoe in an effort to shift load from compromised components to healthier components. In our experience, if the apex of the distal phalanx displaces distal to the lamellar circumflex junction and treatment does not rapidly restore the orientation, then the distal phalanx is resorbed at the distal margin. With continued healing the lamellar circumflex junction may conform to the remodelled apex, but in noncompensated cases the solar dermis and circumflex vessels appear with a reduced amount of contrast on the venogram (**Supplementary Item 9**). Vascular compression is associated with a reduction in sole depth. More extensive bone resorption or septic necrosis of P3 may result in recurrent foot 'abscesses' with associated solar defects (**Supplementary Item 9**).

Conclusion

While multiple factors influence the prognosis and outcome of horses with laminitis, venogram evaluation provides crucial insight into the mechanical compression and distortion of the vasculature affected by the disease process. These mechanical forces can be altered with trimming, shoeing and surgical treatment strategies. Serial venograms help determine the success of treatment in relieving compression and returning an improved vascular state. Critical regions to evaluate on the venogram include the circumflex vessels and the lamellar circumflex junction.

Authors' declaration of interests

No conflicts of interest have been declared.

Ethical animal research

No approval received as this is a retrospective descriptive report of select venographic images to describe the appearance of vascular morphology. There was no alteration of clinical protocol used for these cases.

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Authorship

All authors contributed to the manuscript preparation and have approved the final version.

Manufacturers' addresses

[1]Carbocaine-V. Zoetis, Kalamazoo, Michigan, USA.
[2]Elastikon. Johnson & Johnson, Skillman, New Jersey, USA.
[3]Isovue-300. Bracco Diagnostics, Monroe Twp, New Jersey, USA.
[4]Surflo Winged Infusion Set. Terumo Corp, Tokyo, Japan.

References

Baldwin, G.I. and Pollitt, C.C. (2010) Progression of venographic changes after experimentally induced laminitis. *Vet. Clin. North Am. Equine Pract.* **26**, 135-140.

Leise, B., Miller, N., Moorman, V., Bass, L., Pittman, S., Rucker, A. and Redden, R.F. (2016) *Assessment of digital venograms in non-laminitic horses*. American Association of Equine Practitioners (AAEP). p 297.

Pollitt, C. (2016) The circulatory system. In: *The Illustrated Horse's Foot: A Comprehensive Guide*. Ed: C. Pollitt, Elsevier, St. Louis, Missouri. pp 72-124.

Redden, R.F. (2013) The value of the venogram. In: *Proceedings of Equine Podiatry 101 conference*, Versailles, KY. June 10-14, 2013. pp 47-50.

Rucker, A. (2016) The digital venogram. In: *Equine Laminitis*. Eds: J.K. Belknap, and R.J. Geor, Wiley, Ames, Indiana. pp 240-251.

Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1: Serial venogram images of a sound right forefoot with a progressively increasing palmar angle and non-weightbearing views.

Supplementary Item 2: Variations in the venographic appearance of the lamellar circumflex junction in sound performance horses – Quarter Horse with 20 mm sole depth.

Supplementary Item 3: Variations in the venographic appearance of the lamellar circumflex junction in sound performance horses – Thoroughbred with 10 mm sole depth.

Supplementary Item 4: Variations in the venographic appearance of the lamellar circumflex junction in sound performance horses – Thoroughbred with remodelling of distal margin of P3.

Supplementary Item 5: Variations in the venographic appearance of the lamellar circumflex junction in sound

performance horses – Thoroughbred with grade 1 club foot and remodelling of distal margin of P3.

Supplementary Item 6: Left forefoot with clinical signs of laminitis before and 3 weeks after treatment with shoeing.

Supplementary Item 7: Five-year-old Quarter horse with laminitis following triamcinolone joint injections

Supplementary Item 8: Horse from Supplementary Item 7. Venograms were performed on day 23 and show progression of vascular changes from images shown in Supplementary Item 7.

Supplementary Item 9: Chronic laminitis with extensive bone remodelling and inadequate recovery of vasculature.

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Shoemaker, W.R., Allen, A.L., Richardson, C.E. and Wilson, D.G. (2006) Use of intraarticular administration of ethyl alcohol for arthrodesis of the tarsometatarsal joint in healthy horses. *Am. J. Vet. Res.* **67**, 850-857.

Vlahos, T. (2020) Pantarsal arthrodesis in a pony using a locking compression plate. *Equine Vet. Educ.* **32**, 358.

Voûte, L.C., McDonald, S.A. and Lischer, C.J. (2009) *Refining the three-drill technique for facilitating ankylosis of the distal tarsal joints in horses and establishing performance criteria*. Proc. Europ. Coll. Vet. Surg. Ann. Sci. Meet., Nantes, France 18, 56.

Wilke, V., Robinson, T.M. and Dueland, R.T. (2000) Intertarsal and tarsometatarsal arthrodesis using a plantar approach. *Vet. Comp. Orthop. Traumatol.* **13**, 28-33.

Wyn-Jones, G. and May, G.S. (1986) Surgical arthrodesis for the treatment of osteoarthrosis of the proximal intertarsal, distal intertarsal and tarsometatarsal joints in 30 horses: a comparison of four different techniques. *Equine Vet. J.* **18**, 59-64.

Zamos, D.T. and Honnas, C.M. (1993) Principles and applications of arthrodesis in horses. *Comp. Cont. Educ. Pract. Vet.* **15**, 1533-1541.

Continued from page 384

Manufacturer's address

[1]Zoetis UK Limited, Tadworth, Surrey, UK.

References

Balasuriya, U.B.R. and MacLachlan, N.J. (2014) Equine viral arteritis. In: *Equine Infectious Diseases*, 2nd edn., Eds: D. Sellon and M. Long. Saunders, St. Louis. pp 169-181.

Balasuriya, U.B.R., Carossino, M. and Timoney, P.J. (2018) Equine viral arteritis: a respiratory and reproductive disease of significant economic importance to the equine industry. *Equine Vet. Educ.* **30**, 497-512.

Barquero, N., Gilkerson, J.R. and Newton, J.R. (2007) Evidence-based immunization in horses. *Vet. Clin. North Am. Equine Pract.* **23**, 481-508.

Campbell, M.H., Archer, L. and Wood, J (2018). BEVA/BEF/BHS Equine Viral Arteritis Briefing Document. https://www.beva.org.uk/Home/Resources-For-Vets/Guidance/BEVA-BEF-BHS-Equine-Viral-Arteritis-Briefing-Document (Accessed: 18 February 2018).

Cole, J.R., Hall, R.F., Gosser, H.S., Hendricks, J.B., Pursell, A.R., Senne, D.A., Pearson, J.E. and Gipson, C.A. (1986) Transmissibility and abortogenic effect of equine viral arteritis in mares. *J. Am. Vet. Med. Assoc.* **189**, 769-771.

Doll, E.R., Bryans, J.T., McCollum, W.H. and Crowe, M.E. (1957) Isolation of a filterable agent causing arteritis of horses and abortion by mares; its differentiation from the equine abortion (influenza) virus. *Cornell. Vet.* **47**, 3-41.

Equine Viral Arteritis Order (1995). http://www.legislation.gov.uk/uksi/1995/1755/contents/made (Accessed: 5 July 2018).

Guidance. 2014 Equine viral arteritis: How to spot and report the disease. 26 August 2014 https://www.gov.uk/guidance/equine-viral-arteritis (Accessed: 5 July 2018).

Horserace Betting Levy Board (HBLB) Codes of Practice (2018). Codes of practice. http://codes.hblb.org.uk/ (Accessed: 5 July 2018).

Little, T.V., Holyoke, G.R., McCollum, W.H. and Timoney, P.J. (1991) Output of equine arteritis virus from persistently infected stallions is testosterone-dependant. In: *Equine Infectious Diseases VI*, Eds: W. Plowright, P.D. Rossdale and J.F. Wade. R & W Publications Limited, Newmarket. pp 225-229.

Manser, P. and Westcott, D. (2005) Equine viral arteritis in a stallion. *Vet. Rec.* **156**, 28.

Neu, S.M., Timoney, P.J. and McCollum, W.H. (1988) Persistent infection of the reproductive tract in stallions experimentally infected with equine arteritis virus. In: *Equine Infectious Diseases V*, Ed: D.G. Powell. University Press of Kentucky, Lexington. pp 149-154.

Newton, J.R. (2007) Controlling EVA in the 21st century: 'zero tolerance' or 'live and let live'? *Equine Vet. Educ.* **19**, 612-616.

Newton, J.R., Wood, J.L., Castillo-Olivares, F.J. and Mumford, J.A. (1999) Serological surveillance of equine viral arteritis in the United Kingdom since the outbreak in 1993. *Vet. Rec.* **145**, 511-516.

OIE World Organisation for Animal Health (2013) Chapter 2.5.10, Equine viral arteritis (infection with equine arteritis virus). In: Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2017, http://www.oie.int/fileadmin/Home/eng/Health_standards/tahm/2.05.10_EVA.pdf (Accessed: 5 July 2018).

Pronost, S., Pitel, P.H., Miszczak, F., LeGrand, L., Marcillaud-Pitel, C., Hamon, M., Tapprest, J., Balasuriya, U.B.R., Freymuth, F. and Fortier, G. (2010) Description of the first recorded major occurrence of equine viral arteritis in France. *Equine Vet. J.* **42**, 713-720.

Timoney, P.J. (1985) Clinical, virological and epidemiological features of the 1984 outbreak of equine viral arteritis in the Thoroughbred population in Kentucky, USA. In: *Proceedings, Grayson Foundation of Thoroughbred Breeders Organisations on Equine Viral Arteritis*, pp 24-33.

Timoney, P.J. and McCollum, W.H. (1993) Equine viral arteritis. *Vet. Clin. North Am. Equine Pract.* **9**, 295-309.

Timoney, P.J., McCollum, W.H., Roberts, A.W. and Murphy, T.W. (1986) Demonstration of the carrier state in naturally acquired equine arteritis virus infection in the stallion. *Res. Vet. Sci.* **41**, 279-280.

Timoney, P.J., McCollum, W.H., Murphy, T.W., Roberts, A.W., Willard, J.G. and Carswell, G.D. (1987) The carrier state in equine arteritis virus infection in the stallion with specific emphasis on the venereal mode of virus transmission. *J. Reprod. Fertil. Suppl.* **35**, 95-102.

Wood, J.L.N., Chirnside, J.A., Mumford, J.A. and Higgins, A.J. (1995) First recorded outbreak of equine viral arteritis in the United Kingdom. *Vet. Rec.* **136**, 381-385.

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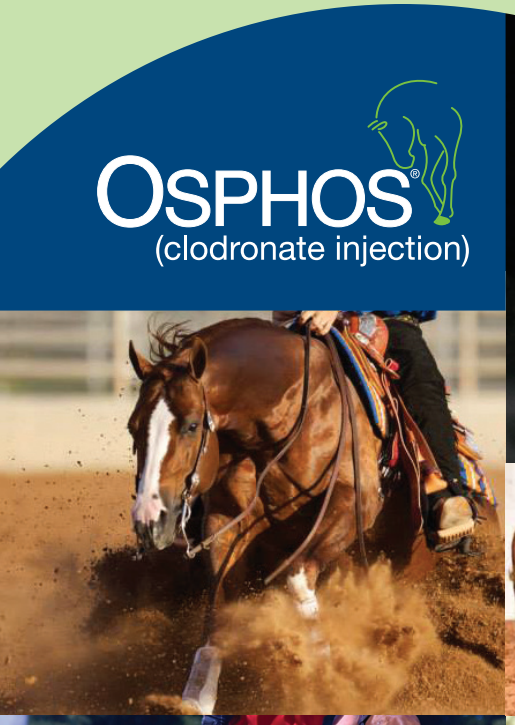



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