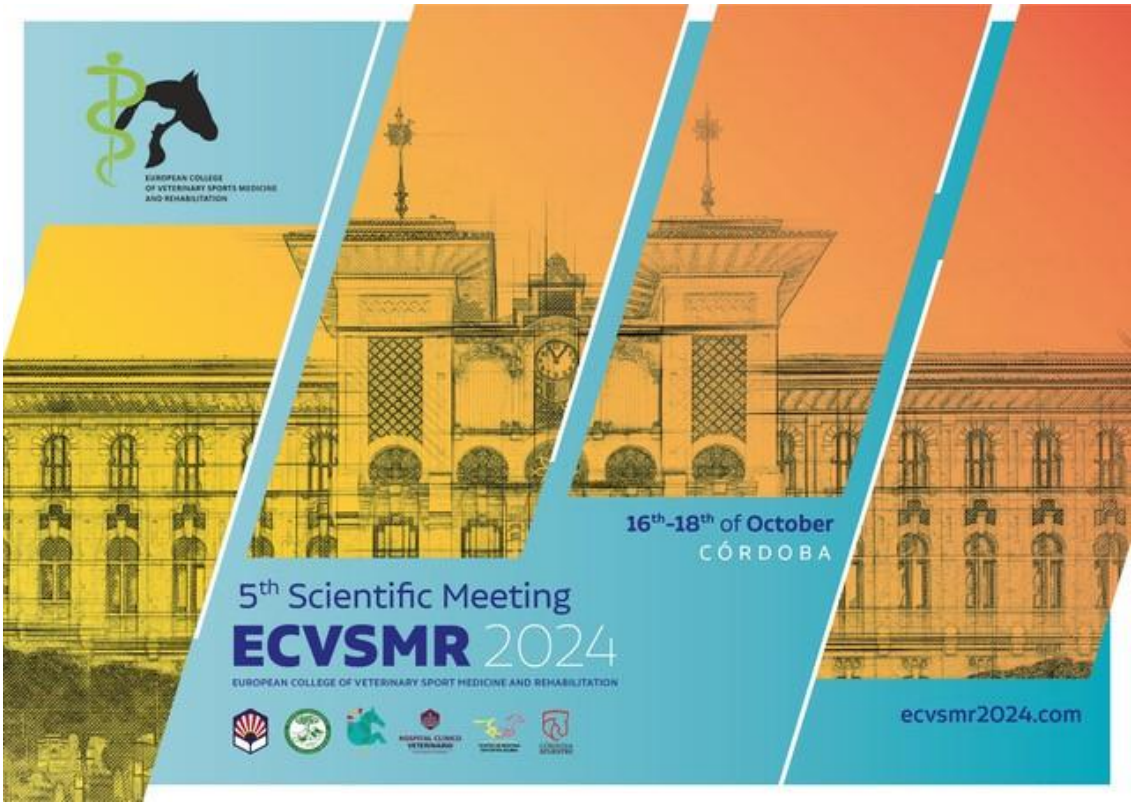
EUROPEAN COLLEGE
OF VETERINARY SPORTS MEDICINE
AND REHABILITATION

Proceedings of the 5th Scientific Meeting of the European College of Veterinary Sports Medicine and Rehabilitation (ECVSMR)



Córdoba, Spain, 16-18 October 2024

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European College of Veterinary Sports Medicine and Rehabilitation (ECVSMR)

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REVIEWERS

- **Small Animals**: Danae Charalambous, Pia Gustås, Marion Muncha, Zoran Vrbanac

- **Equine**: Anna Bergh, José Luis López Rivero, María Martín Cuervo, Annamaria Nagy, Maarten Oosterlinck.

IMPRESSUM

Editor

José Luis López Rivero

Publisher

ECVSMR

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PRESENTATION

We are pleased to present the book of abstracts of the 5th annual scientific congress of the European Veterinary College of Sports Medicine and Rehabilitation, held in Cordoba (Andalusia, Spain) from 16 to 18 October 2024.

Cordoba is an ancient city in which, for centuries, different cultures (Christian, Islamic and Jewish) coexisted and left us an indelible mark and a very valuable legacy. In this brilliant history, the horse has played an important role as the backbone of our culture. Cordoba played a leading role in the creation of a new breed of horse in the second half of the 16th century, the famous Purebred Spanish Horse or Andalusian Horse; and the birth of the veterinary profession in Spain, hosting the second oldest Veterinary School in the country, created 175 years ago.

The scientific content of the Congress is divided into two complementary programs. A main program, held in the imposing building of the current Rectorate of the University of Cordoba (former headquarters of the Faculty of Veterinary Medicine) for two days; and a training program consisting of 4 practical workshops and a forum for residents of the College held in the premises of the Veterinary Hospital of the University of Cordoba on 16th October as a preamble to the meeting.

It ran parallel sessions on small animals and equine. It was attended by 327 participants, of which approximately 110 attended the small animal program and 217 the equine program. The 4 workshops were attended by 94 participants, 34 for small animals and 60 for equines. Some 30 invited speakers, all of them specialists in veterinary sports medicine and rehabilitation, took part in the workshops and conference. Fifty-eight abstracts were received as free communications (39 in the equine program, 13 in the small animal program, and 6 in the congress residents' forum). Following a peer review process by the congress scientific committee, 21 abstracts were selected as oral communications (8 in equine, 8 in small animals and 5 in the residents' forum) and a further 27 abstracts were accepted as posters (24 in equine and 3 in small animals).

In the venue that hosted the main program of the congress, a commercial space was set up around the commercial exhibitors where the coffee breaks and lunches were held on the 17th and 18th. 10 sponsoring companies collaborated in different ways: 1 gold sponsor, 3 silver sponsors, 5 stands and 1 occasional collaborator.

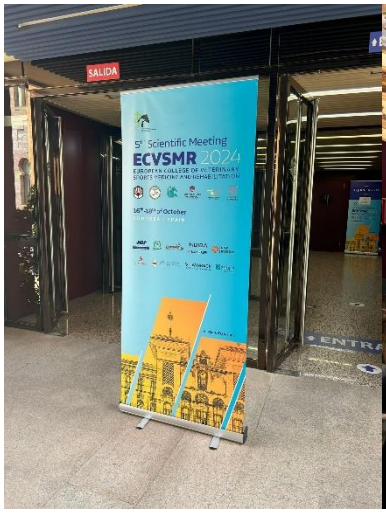
Apart from the scientific program, an attractive social program included a visit to the historic Royal Stables of Cordoba, followed by an Equestrian Show by the Cordoba Equestrian Cultural Association, and a welcome cocktail at the Rectorate of the University. The attendees also enjoyed an evening visit to the majestic Mosque-Cathedral, the heart and soul of Cordoba, followed by an elegant gala dinner with flamenco singing and dancing at the Real Circulo de la Amistad de Córdoba.

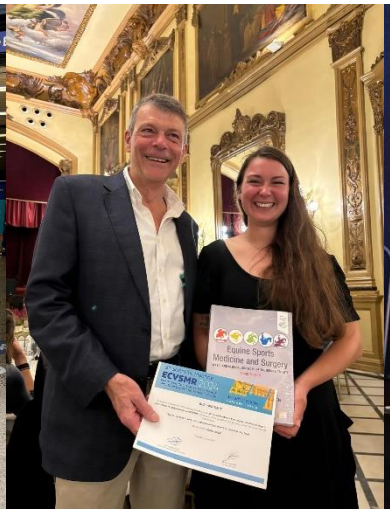
During the cocktail reception, the awards for the best papers presented at the college's residents' forum were presented by our gold sponsor VAHL Veterinary Academy of Higher Learning. In addition, at the end of the gala dinner, the awards for the two best abstracts presented at the congress were offered by Saunders Elsevier Publishers.

The Organizing Committee would like to thank all the participants for their contribution to the success of the congress, wishing them a worthwhile educational learning experience and a pleasant stay in the beautiful city of Cordoba.

José Luis López Rivero
Organising Committee, Chair

PHOTO GALERY


SALIDA
5th Scientific Meeting
ECVSMR 2024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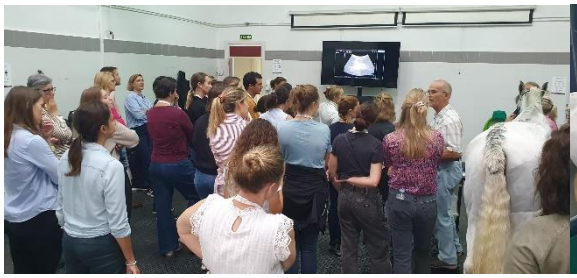

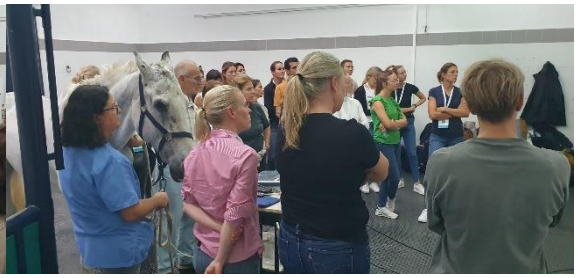

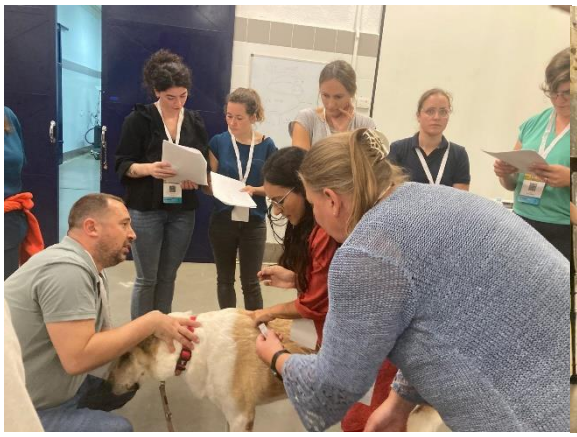

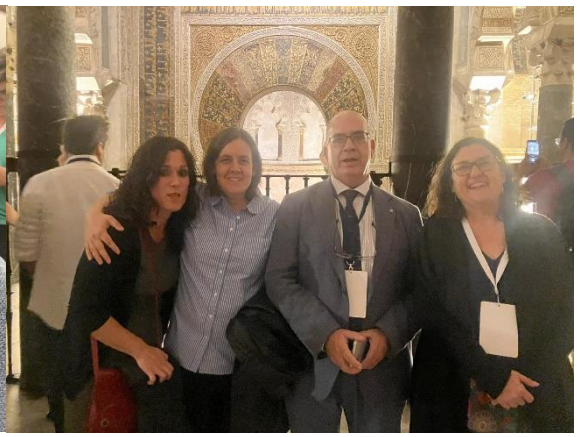

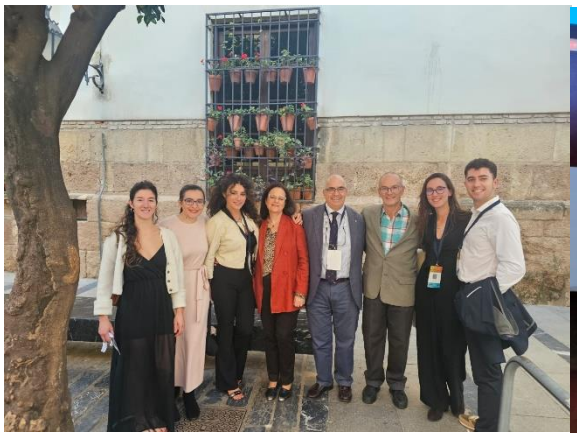

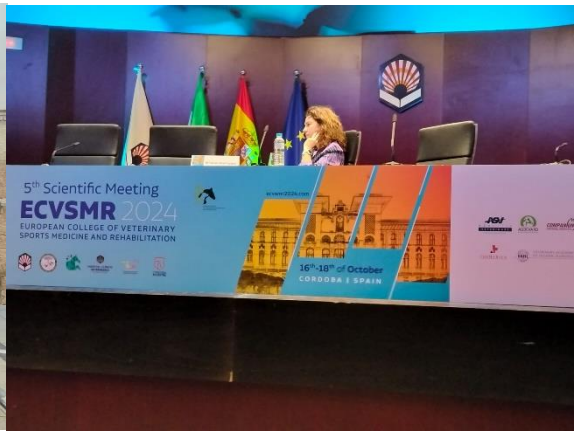
5th Scientific Meeting
ECVSMR 2024
EUROPEAN COLLEGE OF VETERINARY SPORTS MEDICINE AND REHABILITATION
16th-18th of October
CORDOBA | SPAIN

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PROGRAMS

SMALL ANIMALS PROGRAM

Workshops (Rabanales University Campus)

Wednesday October 16, 2024

09-12:30 h	Electroacupuncture: complementary therapy for pain management and neuropathies (University Clinical Veterinary Hospital) • Analgesic electrotherapy options: how to apply invasive TENS • Neuromodulation for axial pain management • Neuromodulation for hip pain management • Acupoints for neuropathies management (Z. Vrbanac, M. Mucha and T. Hernández)
14:00-16:30 h	Exercise tests for monitorization of training (University Clinical Veterinary Hospital) • Introduction to monitorization of training • Understanding exercise test: practice examples • Elaboration of training program based on results • How to introduce the companion dog to sport exercise (J. Alves, and N. Pastor)

RESIDENT FORUM

16:30-17:25 h

EVENING PROGRAM

19:00 h – 20:00 h	Equestrian show at Royal Stables
21:00 h – 24:00 h	Welcome cocktail at the Rectorate of the University of Cordoba

MAIN PROGRAM

(Rectorate of the University of Cordoba - Former Faculty of Veterinary Medicine)

Thursday October 17, 2024

08:00-08:45 h	Registration
08:45-09:00 h	Opening ceremony

SESSION I SPORT DOGS: DOGS WITH A BIG HEART

KEYNOTE SPEAKER

Chair: D. Joao Alves

09:00-09-30 h	Keynote speaker. Sport and working dogs: historical veterinary vision (S. Maffi)

ORAL COMMUNICATIONS

09:30-09:45 h	Multimodal contextualized approach to dogs with fibrotic myopathy (Mila Speciani)
09:45-10:00 h	Surface electromyography of the lateral triceps and biceps brachii muscles in dogs during selected therapeutic exercises (Darryl Millis)

10:00-10:30 h Coffe break

10:30-11:00 h	The role of veterinarians in dog sports competitions (S. Maffi)
11:00-11:30 h	Cardiovascular system in sporting dogs: physiological adaptations and their recognition (A. Boraita, and D. Porteiro)
11:30-12:00 h	Cardiovascular system in sport: a comparative perspective (A. Boraita, and C. Navas)
12:00-13:00 h	Annual General Meeting

13:00-14:00 h Lunch, Poster session

SESSION II TRAINING AND INTRODUCTION TO SPORT

Chair: G. del Pueyo (University Complutense of Madrid)

14:00-14:30 h	Keynote speaker. Rehabilitation of sport dogs: how to return to competing (S. Maffi)
14:30-15:00 h	Elaboration of training programs: how to apply in our practice (J. Alves)

ORAL COMMUNICATIONS

15:00-15:15 h	Enhancing Veterinary Sports Medicine: Thermographic Patterns in Athlete Dogs (Irene Díaz Artiago)

15:15-15:30 h	Factors associated with falling from the dogwalk in agility dogs (Leena Inkilä)

15:30-16:00 h Coffee break

16:00-16:30 h	Prevention of injuries in agility dogs (A. Pechette Markley Online)
16:30-17:00 h	Hot topics in agility dogs (A.Pechette Markley Online)

Friday October 18, 2024

Rehabilitation

SESSION III NEUROLOGY REHABILITATION

Chair: B. Bockstahler (University of Veterinary Medicine Vienna)

09:00-09:30 h	Keynote speaker. Neurology patient: evolution of the rehabilitation review of last 15 years. (G. del Pueyo)
09:30-10:00 h	Rehabilitation of in the neurology patients: new tendencies (A. Martins)

10:00-10:30 h Coffee break

10:30-11:00 h	Rehabilitation of atypical cases in the neurology patient (A. Martins)
11:00-11:30 h	Unveiling canine aging: exploring postural stability changes, measurement techniques, and implications for physiotherapy (B. Bockstahler)

SESSION IV CARDIOLOGY AND REHABILITATION

Chair: D. Porteiro

ORAL COMMUNICATIONS

11:30-11:45 h	Technique for subcutaneous adipose tissue extraction from cranial to the manubrium to produce autologous mesenchymal stem cells and clinical outcome in 39 dogs (James Guthrie)
11:45-12:00 h	Transcutaneous electrical spinal cord stimulation in deep pain negative dogs with thoracolumbar intervertebral disc extrusion – A controlled pilot study (Angela Martins)

12:00-12:30 h	Rehabilitation in patients with heart disease: monitoring and limits. (G. del Pueyo)
12:30-13:00 h	Cardiac rehabilitation in veterinary patients (A. Martins)

13:00-14:00 h Lunch, Poster session

SESSION V COMPLEMENTARY THERAPIES

Chair: M. Mucha (Outpatient Clinic for Physical Therapy and Rehabilitation, Vetmeduni, Vienna)

14:00-14:45 h	Keynote speaker. Kinesiotaping: evidence and how can help to our rehabilitation patients (S. Mikail)
14:45-15:30 h	Mesotherapy: evidence and treatment recommendations (J. Alves)

ORAL COMMUNICATIONS

15:30-15:45 h	Conservative treatment of post traumatic spinal fracture and subluxation in a cat: a case report. (Marta Alessandra Frigerio)

15:45-16:15 h Coffee break

ORAL COMMUNICATIONS

16:15-16:30 h	Retrospective Evaluation of Treatment Outcomes for Sesamoid Disease in Dogs: 2018-2022 (Dominique Palper)
16:30-17:15 h	Acupuncture: evidence and how can help to our rehabilitation patients (Z. Vrbanac)
17:15-17:45 h	Round table on Integrate complementary therapies to rehabilitation and sport medicine (Z. Vrbanac, Marion Mucha, and J. Alves)
17:45-18:00 h	Clossing ceremony

EQUINE PROGRAM

Workshops (Rabanales University Campus)

Wednesday October 16, 2024

09-12:30 h	Muscular wet lab (University Clinical Veterinary Hospital)
	•Muscle biopsy: how to do it and sent it
	(S. Valberg)
	•EMG examination: indications and how to do it
	(I. Wijnberg)
	•Imaging muscle disorders
	(J. M. Denoix)

12:30-14:00 h Lunch

14:00-16:30 h	Rehabilitation techniques (University Equine Sports Medicine Center)
	•Physical therapies
	(A. Muñoz and D. Argüelles)
	•Updating of rehabilitation techniques
	(K. Haussler)
	•Devices available to rehabilitate horses
	(S. Cokelaere)

RESIDENT FORUM

16:30-17:25 h

EVENING PROGRAM

19:00 h – 20:00 h	Equestrian show at Caballerizas Reales
21:00 h	Welcome cocktail

MAIN PROGRAM

(Rectorate of the University of Cordoba - Former Faculty of Veterinary Medicine)

Thursday October 17, 2024

08:00-08:45 h	Registration
08:45-09:00 h	Opening ceremony

SESSION I MUSCULAR PROBLEMS

Chair: E. Aguilera-Tejero (University of Córdoba)

09:00-09-30 h Keynote speaker. Diagnosis and management of exertional rhabdomyolysis

(S. Valberg)

ORAL COMMUNICATIONS

09:30-09:45 h Can the horse grimace scale be used as an indicator of pain in low-grade lame sport horses at rest?

(Irene Nocera)

09:45-10:00 h Determination of the different phases of the horse swim cycle and correlation to the limbs kinematic obtained by underwater 3D motion capture analysis: preliminary results.

(Moiroud Claire)

10:00-10:30 h Coffee break

10:30-11:00 h Assessment of skeletal muscle oxidative capacity for training monitoring, fitness evaluation and detection of mitochondrial dysfunction in sport horses.

(D. Votion)

11:00-11:30 h Diagnosis and management of other external myopathies

(S. Valberg)

11:30-12:00 h Nutrition in the equine athlete with poor performance

(I. Vervuert)

12:00-13:00 h Annual General Meeting

13:00-14:00 h Lunch, Poster session

SESSION II SPORT MEDICINE

Chair: A. Muñoz. (University of Cordoba)

14:00-14:30 h Keynote speaker: Improving performance and injury prevention using mobile health

(C. Navas)

14:30-14:50 h	Hot topics in endurance horses (thumbs, cardio, etc..) from the point of view of internal medicine (E. J. Cunilleras)
14:50-15:10 h	Hot topics in dressage horses from of point view of musculoskeletal system (A. Boado)
15:10-15:30 h	Hot topics in showjumpers and three-day eventers from of point view of musculoskeletal system (J. M. Romero)

15:30-16:00 h Coffee break

16:00-16:20 h	Hot topic in dressage, showjumpers and three-day eventers from of point view of internal medicine (E. van Erck)
16:20-16:40 h	Exercise associated sudden deaths or sudden athletic deaths (C. Navas)
16:40-17:00 h	Round table: Doping in sport horses FEI vs racehorses regulations? (C. Termine, M. J. Rodríguez and M. Varela)

Friday October 18, 2024

SESSION III UPDATING DIAGNOSIS

Chair: M. J. Rodríguez, Spain

09:00-09:30 h	Keynote speaker. Nutrition in high level sport horses: speed vs endurance (I. Vervuert)
09:30-10:00 h	Imaging head and neck in the neurological sport horse (G. Manso)

10:00-10:30 h Coffee break

10:30-11:00 h	Poor performance: specific tests according with the discipline

(E. van Erck

11:00-11:30 h Diagnosis of the cervicothoracicobrachial syndrome

(J. M. Denoix)

ORAL COMMUNICATIONS

11:30-11:45 h Acid-base imbalances in Standardbred racehorses after a 2150 m race by traditional and simplified strong ion difference methods.

(Marc Rebassa-Cicerol)

11:45-12:00 h Equine Lameness Detection and Monitoring with an Instrumented Hoof Boot

(Jasmin Keller)

12:00-12:15 h Comparison between in hand locomotion and harnessed locomotion in driving horses using a gait analysis system: a pilot study.

(Virginie Coudry)

12:15-12:30 h Functional assessment of coronary haemodynamic response to negative chronotropism

(Marta Valero González)

12:30-13:00 h Diseases that can be diagnosed by EMG

(I. Wijnberg)

13:00-14:00 h Lunch, Poster session

SESSION IV REHABILITATION AND THERAPIES

Chair: D. Argüelles (University of Cordoba)

14:00-14:45 h Keynote speaker. Update of rehabilitation techniques on spinal pathology

(K. Haussler)

14:45-15:15 h Biomechanical bases of equine rehabilitation

(J. M. Denoix)

ORAL COMMUNICATIONS

15:15-15:30 h Autologous conditioned serum benefits inflammatory resolution compared to triamcinolone in a IL-1B synovitis model

(Ana Velloso Álvarez)

15:30-15:45 h Echocardiography of jumping horses trained for 10 weeks using the water treadmill

(Joana Simões)

15:45-16:15 h Coffee break

16:15-16:45 h	Equine myofascial therapy/techniques (K. Haussler)
16:45-17:15 h	Regenerative therapies: state of the art and critical update event (S. Cokelaere)
17:15-17:45 h	Kinesiotaping applications on sport horses (S. Mikail)

17:45-18:00 h Closing ceremony

KEYNOTE SPEAKERS

SMALL ANIMALS PROGRAM

Sergio Maffi

A veterinary surgeon from the University of Milan, he has been practising as a private practitioner since 1988 in his own clinic in Palazzolo sull'Oglio (BS). Over the years, Dr Maffi has directed his professional interests towards the medicine of sporting and working dogs, taking a particular interest in dogs involved in dog sledding and cani-cross. After permanent recognition of his degree in Scandinavian countries (Norway 2010; Sweden 2011) and temporarily in Alaska (2013), Dr. Maffi has dedicated himself as Chief Vet or Race Vet to the management of the welfare and health of dogs engaged in long-distance dog sledding competitions, becoming from 2010 to today the only Italian Veterinarian responsible for the organization of the veterinary teams operating in international competitions in Norway ("Bergebyløpet N70", a 650 km race, the only race in the world to be held entirely beyond the Arctic Circle) and in Sweden ('Polardistans', a 300 km race reserved for dogs of FCI-recognized Nordic breeds, and 'Vildmarksracet', a 120 km race, tackled by many mushers as their first introduction to long-distance competitions). His passion for sled dogs has also led Dr Maffi to work in other international dog sledding competitions, working as a Race Vet in both North American competitions ("Yukon Quest" - 1600 km in the Yukon Territory, Canada and Alaska, USA; "Hudson Bay Quest" - 500 km in Manitoba, Canada; "Race to the Sky" - 500 km in Montana, USA) as well as in European competitions, including 10 editions of "Finnmarksløpet" (Europe's longest 1,200 km race), 7 editions of "Femundløpet" (650 km race that, with more than 150 teams of 8 or 12 dogs registered each year, is the world's most popular long-distance dog sledding competition) and in numerous editions of other races, such as "Amundsen Race", "Beaver Trap Trail", "Spain Long Distance", etc. Dr. Maffi has also served (as Chief Vet, Race Vet, Veterinarian of national teams or as Anti-Doping Commissioner) in national, European or world championships for some of the various federations and organizations that govern these dog activities on snow or on land (IFSS, WSA, ICF, FISTEC, FIDASC, CSEN), as well as in international competitions, both sprint and long-distance, sleddog and canicross, in European countries (France, Great Britain Spain, Switzerland, Poland, Czech Republic, Finland, Russia, Latvia, Iceland) and outside Europe (Canada, USA, South Africa). Author of papers at national and international congresses dedicated to sled dogs, Dr. Maffi is a member of the Board of Directors of ISDVMA (International Sled Dog Veterinary Medical Association), a member of "Mush with Pride", a founding member and Past Vice-President of AIM (Italian Mushers Association), a founding member and member of the Board of Directors of AIVSeC (Italian Association of Veterinary Sleddogs and Canicrosses) and AMeSVI (Italian Veterinary Medical Sports Association). Among other activities in the veterinary field, Dr Maffi also regularly follows greyhound coursing competitions, agility competitions and sports events, and search and rescue activities. Dr Maffi has also taken part as a volunteer surgeon in numerous 'catch/spay/vaccinate/release' campaigns for stray dogs in Ladakh and Sikkim (India), South Africa, Romania and Spain.

Gemma del Pueyo

Graduated in Veterinary Medicine from the Complutense University of Madrid. Certified inVeterinary Massage and Rehabilitation by the HWOC of Wisconsin (USA) and the ESAVS. American Diploma in Sports Medicine and Rehabilitation. AVEPA Accredited in Veterinary Physical Rehabilitation. Director of the Rehabilitation and Sports Medicine service at the VETSIA Veterinary Hospital. She was first diplomate in small animals from Spain and participated as a

professor in the postgraduate degree in veterinary physiotherapy at the UCM and Forvet. She is a senior lecturer in rehabilitation of small animals.

Solange Mikail
Diplomate American College of Veterinary Sports Medicine and Rehabilitation, Equine Physiotherapist Team Leader in Rio 2016 Olympics and Paralympic Games and owner of the Vet Physio Institute. She is the author of many articles and books. Dr. Mikail is a pioneer in the field of equine rehabilitation and thermography.

EQUINE PROGRAM

Stephanie Valberg
Stephanie Valberg, the Mary Anne McPhail Dressage Chair in Equine Sports Medicine, is professor and director of the Neuromuscular Diagnostic Laboratory. She received her DVM from the University of Guelph Ontario Veterinary College and her PhD in equine exercise physiology from the Swedish University of Agricultural Sciences. She is board certified in large animal internal medicine and veterinary sports medicine and rehabilitation. Valberg is an international leader in understanding and managing equine neuromuscular disorders. The overarching goal of Valberg's research and clinical work is to define the basis for neuromuscular disorders in horses, develop accurate, minimally invasive diagnostic tests, and produce optimal methods for preventing or managing performance limiting diseases. Valberg's work in equine muscle disease has transformed equine clinical practice. Her research has led to the discovery of previously unknown muscle disorders, identification of their genetic basis, and development of nutritional strategies to minimize muscle pain. Valberg is widely published, and has mentored graduate students, interns, residents, and post-doctoral students and is a recipient of numerous awards such as the 2014 Richard Hartley Clinical Award from the British Equine Veterinary Association for her research linking seasonal pasture myopathy to box elder tree seeds. In 2012, Valberg became the first woman to be inducted into the Equine Research Hall of Fame. She has twice received the Pfizer Research Excellence Award, and in 1998 received the EquiSci International Award, an honor presented every four years to the individual whose work most significantly impacts equine exercise physiology research.

Cristobal Navas
Dr. Navas received his veterinary degree from the UCH-CEU University in Valencia, Spain, Phd from UAB, Barcelona, Spain and Master of Veterinary Clinical Medicine from the University of Illinois. He completed a residency in Equine Internal Medicine (University of Illinois) and Fellowship in Cardiology and Ultrasound (University of Pennsylvania) and is a Diplomate of the American College of Veterinary Internal Medicine since 2009. Before starting formal Internal Medicine training, he worked in an equine ambulatory practice. Dr. Navas joined Texas A&M as Clinical Assistant Professor from 2015-2019 and returned to PennVet in 2019. His clinical activity and research focus in equine cardiology and ultrasound. Dr. Navas' ongoing projects are designed to prevent injuries and exercise associated deaths in equine athletes and to promote veterinary health and education using telehealth. The VVCA is delighted to have an academician on the Data Strategy committee, helping us dig deep into what types of data will be valuable to veterinary practitioners and teams.

Ingrid Vervuert
Professor Dr. med. vet. Ingrid Vervuert. Veterinarian Animal Nutrition and Dietetics. Acting Head of Initiated on Animal Nutrition, Nutritional Damage and Dietetics. Dr. Vervuert is a Doctor of

Animal Nutrition and habilitated for animal nutrition and dietetics. Since 2016, she has been responsible for the entire range of tasks of the institute in teaching and she is a long-standing head of the service sector. To expand her teaching competence, she has completed a highly debt-acting certificate program. Her research activities focus on the area of obesity and the development of feeding concepts for the prevention of stomach ulcers in farm animals with a focus on horses. In addition, she is involved in a recent project with the occurrence of pyrrolizidine alkaloids in supplementary feeds for horses. In June 2019, she was appointed as adjunct professor.

Kevin Haussler

Kevin K. Haussler, DVM, DC, PhD, Dipl. ACVSMR, graduated from The Ohio State University College of Veterinary Medicine in 1988 before completing a small animal internship. To further his training in conservatively managing spinal-related disorders, he pursued human training at Palmer College of Chiropractic-West and completed a veterinary chiropractic certification program in 1993. He completed his PhD, focusing on spinal pathology and pelvic biomechanics in Thoroughbred racehorses, from the University of California, Davis, and then studied equine spinal kinematics at Cornell University. While at Cornell, he directed the newly formed large and small animal Integrative Medicine Service. Currently, Haussler is an associate professor at the Colorado State University (CSU) Orthopedic Research Center, where he's involved in teaching, clinical duties, and researching. He is a charter diplomate of the American College of Veterinary Sports Medicine and Rehabilitation and a course instructor for the Equine Rehabilitation Certification course, co-branded by the University of Tennessee and CSU.

INVITED SPEAKERS

SMALL ANIMALS PROGRAM

João Alves

João Alves graduated from the University of Lisbon, Portugal, in 2012 and has since worked at the Guarda Nacional Republicana (Portuguese Gendarmerie) with their police working dogs, focusing on sports medicine and rehabilitation, helping these animals to achieve their full potential. He completed his PhD in 2021 from the University of Évora, Portugal, in intra-articular management modalities for osteoarthritis. In 2022, he became a European Specialist in Canine Sports Medicine and Rehabilitation (Diplomate of the European College of Sports Medicine and Rehabilitation - Small Animals; DECVSMR). In addition to osteoarthritis, he does research and is interested in working dog sports medicine, photobiomodulation therapy, and canine exercise. João has published dozens of papers and lectures frequently on these topics.

Barbara Bockstahler

She studied veterinary medicine in Vienna, Austria, where she later headed a joint veterinary practice. Since 1999 she is head of the section for Physical Therapy and Rehabilitation at the University of Veterinary Medicine Vienna. In the course of her clinical and scientific career Dr. Bockstahler has held numerous national and international lectures. Dr. Bockstahler was certified as a Specialist for Physical and Rehabilitation Medicine in 2004 (Austria) and as Certified Canine Rehabilitation Practitioner in 2007. She conducted intensive research on gait analysis in dogs since 2003 and finished her habilitation 2009. She became Diplomate of the American College for Veterinary Sports Medicine and Rehabilitation 2016. She is a founding member and current past president of the European College of Veterinary Sports Medicine and Rehabilitation.

Araceli Boraita

Bachelor of Medicine and Surgery from the University of Zaragoza (1979) and Specialist in Cardiology at the Jiménez Díaz Foundation Hospital, Madrid (1987). She is also a specialist in Sports Medicine from the School of Sports Medicine at the Complutense University of Madrid (2007). Doctor of Medicine with the distinction of Summa Cum Laude by Unanimity from the Autonomous University of Madrid "Adaptation of the aortic root to training: Study in Spanish high-performance athletes" (2014). She was Head of the Cardiology Service at the Sports Medicine Center, Higher Sports Council from May 1988 to December 2021, Madrid, Spain. She is responsible for the cardiovascular assessment of Spanish elite athletes prior to competition and for monitoring before European Cups, World Championships, or participation in the Olympic and Paralympic Games during 8 Olympic cycles (Barcelona 92, Atlanta 1996, Sydney 2000, Athens 2004, Beijing 2008, London 2012, Rio de Janeiro 2016, and Tokyo 2020). Dedicated to both research and the promotion of scientific advances in the field of cardiology and sports. Founder of the Working Group on Cardiology in Sport and Physical Activity of the Spanish Society of Cardiology (1991) and the National Registry of Sudden Death in Sport, Spanish Societies of Sports Medicine and Cardiology (2010). Her research interests include the study of morphological and functional cardiac adaptation to high-performance sports, and the prevention of sudden death in sports through the study of its main causes and facilitating mechanisms.

Ângela Martins

Ângela Martins, graduated in veterinary medicine since 1991 on the Faculty of Veterinary Medicine in Lisbon, and with a PhD in functional neurorehabilitation in 2023 from the same

University. Diplomate of the European College of Veterinary Sports Medicine and Rehabilitation (Dipl. ECVSMR) since 2023. Founder of Arrábida Veterinary Hospital and the first Animal Functional Rehabilitation Center (CRAA) in Portugal. Clinical Director of Lisbon Animal Rehabilitation and Regeneration Center (CR2AL). Professor on Lusófona University in the disciplines of Animal Rehabilitation and Emergency and Intensive Care, and coordinator of the degree in Veterinary Nursing at IPLUSO. Certified and instructor of the Certified Canine Rehabilitation Practitioner (CCRP) from the University of Tennessee. Attended several international congresses on rehabilitation, in veterinary medicine as in human medicine. Speaker at various events in Portugal and internationally on the topic of animal neurorehabilitation. She has published several articles in quartile 1 journals, as well as a participant in books chapters, author of several posters on the same theme and other scientific works, in functional rehabilitation.

Marion Mucha

She is veterinary medicine in Vienna, Austria and was already involved in physiotherapy as part of her doctoral thesis, which was completed in 2005. Since 2002 she worked in the Outpatient Clinic for Physical Therapy and Rehabilitation at the Vetmeduni Vienna. During her clinical and scientific career, she has given many lectures in Austria and abroad and conducted research in the field of movement science, physical therapy and acupuncture in dogs. Since 2004 she is a certified veterinary acupuncturist (CVA, IVAS International Veterinary Acupuncture Society), since 2007 certified physiotherapist for dogs (CCRP, Certified Canine Rehabilitation Practitioner, University of Tennessee in cooperation with Schlossseminare). 2010 her book "Checklist Acupuncture for Small Animals" was published. Since 2016 she is CVPP (Certified veterinary pain practitioner, IVAPM) and since 2018 European Veterinary Specialist in Veterinary Sports Medicine and Rehabilitation (Dipl ECVSMR).

Arielle Pechette Markley

Dr. Arielle Pechette Markley is an Assistant Professor of Sports Medicine and Rehabilitation at The Ohio State University College of Veterinary Medicine. She earned her DVM from Colorado State University in 2010, during which time she also became certified in veterinary acupuncture. After graduation she worked in emergency medicine and general practice where she developed a passion for pain management and rehabilitation. She went on to complete her Certified Veterinary Pain Practitioner certification through IVAPM and her Certified Canine Rehabilitation Therapist certification through the Canine Rehabilitation Institute. She then started sports medicine and rehabilitation specialty practice in Indianapolis, Indiana. In 2018 she began working at The Ohio State University Veterinary Medical Center and helped to start up a new Sports Medicine and Rehabilitation program. Her position allows her to see a variety of orthopedic, neurological, geriatric and sports medicine cases. She has also completed research in the field of canine agility injuries and has received funding from the Morris Animal Foundation for research on lumbosacral disease. She has more than 30 publications about agility dogs, including the last issue of Veterinary Clinics of North America Small Animal Practice focused on rehabilitation about “Management of injuries in Agility Dogs”. Dr. Arielle Pechette Markley form part of the Agility Dogs Health Network a platform to encourage collaboration among individuals engaged in evidence-based discovery and innovation to enhance the health of dogs competing in canine agility and to disseminate that information to agility participants. Her special interests include biomechanics, pathophysiology, prevention and treatment of sport-specific injuries in canine athletes, particularly in dogs competing in agility competitions.

Dolores Porteiro

Dolores Porteiro graduated from the College of Veterinary Medicine of Santiago de Compostela in 2005. Between 2005 and 2011, she collaborated with different Clinics in Madrid (Spain). She

completed a cardiology intership from February 2012 to July 2013 with Doctor Claudio Bussadori and Doctor Roberto Santilli (Italy). In 2021 she obtained the European Diploma of Internal Medicine Specialty of Cardiology. She is the head of the cardiology department of the Hospital Veterinario Puchol (Madrid, Spain) and she's co-worker with Dr. Roberto Santilli for the telemedicine service "ecgontheweb.com". She has published in different national and international journals. Also, she has presented scientific articles in national and international congress. She is co-author of the book "Cardiología clínica en el perro y en el gato". Her main research activities include the arrhythmology.

Zoran Vrbanac

DECVSMR (Small Animals), DACVSMR (Canine), DVM, PhD. EBVS® European Specialist in Veterinary Sports Medicine and Rehabilitation. Member of European College of Veterinary Sports Medicine and Rehabilitation. Dr. Zoran Vrbanac earned his veterinary degree and PhD in Clinical Veterinary Sciences at the Faculty of Veterinary Medicine University of Zagreb, Croatia. In 2008 he completed training in veterinary acupuncture at the College of Veterinary Medicine, China Agricultural University in Beijing, PR China. Dr. Vrbanac is an Assistant Professor at the Department of Radiology, Diagnostic Ultrasound and Physical Therapy, Faculty of Veterinary Medicine University of Zagreb, Croatia. He was one of the founding members of VEPRA (Veterinary European Physical Therapy and Rehabilitation Association) and has served two terms as president of VEPRA. He became Diplomate of the American College for Veterinary Sports Medicine and Rehabilitation in 2016.

EQUINE PROGRAM

Ana Boado

Her vocation began at age 5 when he started with a special interest in horses. After riding horses for years in both the United States and England and taking several courses as a riding instructor, she decided to study veterinary medicine to dedicate herself to the world of horses.

Stefan Cokelaere

Doctor Stefan Cokelaere originates from Belgium and graduated from vet school at the University of Ghent in 2001. After his study, he did multiple externships abroad including in London, Ontario (Canada), Newmarket (United Kingdom) and in Ohio (United States of America). Furthermore, Stefan completed a yearlong internship at the Veterinary Clinic de Bosdreef in Moerbeke-Waas (Belgium). From 2002-2005, Stefan completed a large animal surgical residency at the University of Ghent. In 2007, he received his diploma as European Specialist Surgery (Diplomate ECVS – European College of Veterinary Surgeons). After his residency, Stefan worked for 2 years as a specialist in surgery and orthopedics at Veterinary Clinic De Morette (Asse, Belgium) and at Veterinary Clinic de Bosdreef (Moerbeke-Waas, Belgium). In 2008, Stefan moved to the Netherlands and worked there for more than 10 years at the University Clinic for Horses at the University of Utrecht. There Stefan was a senior surgeon in the surgery department, and he was responsible for equine surgery and orthopedics. His main interest lies in orthopedics (lameness and vertebral column problems), sports medicine, rehabilitation, and orthopedic surgery. After training for 2 years, Stefan received the FES (Focus on the Equine Spine) diploma for equine chiropractics in 2010. In 2016, Stefan also received board certification for the American sports medicine and rehabilitation (Diplomate of the American College of Veterinary Sports Medicine and Rehabilitaiton). Stefan wrote several scientific articles and is currently finalizing his Doctoral thesis regarding new surgical and medical treatments of joints. Starting November 1st, 2018, Stefan is working at SMDC (Sporthorse Medical Diagnostic Centre).

J. M. Denoix

A horse physiotherapist of international repute and renowned leader in equine anatomy and imaging, Dr. Jean-Marie Denoix has mentored many around the world throughout his career. Born in France in 1954, Dr. Denoix grew up helping his father on commercial fishing boats off the coast of Normandy while he finished his education. He studied anatomy and veterinary medicine, graduating from veterinary school in Lyons in 1977. Professor Denoix went on to study anatomy, imaging, and biomechanics, lecturing extensively on these subjects in 30 countries. Dr. Denoix is Professor of Veterinary Anatomy and Equine Locomotor System Pathology and Rehabilitation at the National Veterinary School in France, an ACVSMR Diplomate and Founding Diplomate of the European College of Veterinary Sport Medicine and Rehabilitation. He has pioneered some of equine medicine's most innovative techniques in imaging, particularly ultrasound, and has communicated this new information via numerous lectures, books and more than 40 peer-reviewed publications. Dr. Denoix has donated his time to being the imaging specialist at two World Equestrian Games to further the welfare of the horse in sport. He has worked with multiple farrier organizations to help farriers better understand the anatomy and biomechanics of the equine hoof. His functional anatomy books have helped veterinarians and veterinary students understand the anatomy of the foot and entire horse in a level of detail and comprehension not accomplished previously. Through his work with the International Society for Equine Locomotor Pathology, he has taught in concentrated three-day blocks to 10,000 veterinarians around the world, furthering their clinical abilities. Dr. Denoix has been a principal figure in the advancement of equine musculoskeletal diagnostics. His vast knowledge of equine anatomy coupled with his enthusiasm for diagnostic imaging, particularly ultrasound, has opened new doors for understanding pathophysiology of equine musculoskeletal disorders. Through his teaching and publications, he has enabled practitioners throughout the world to practice an advanced level of diagnostic medicine not previously thought possible.

Gabriel Manso

Degree in Veterinary, obtaining the Extraordinary National Award, Master in Research in Veterinary Sciences and Doctor in Veterinary Medicine with European mention, obtaining the Extraordinary Doctorate Award. He completed an official European residency in Diagnostic Imaging of Large Animals at the Royal Veterinary College of the University of London, obtaining the title of Diploma by the European College of Veterinary Imaging (ECVDI). In addition, he has carried out multiple specialized training stays in prestigious centers in the United States and the United Kingdom. Author of several indexed scientific articles, books and communications in congresses in the field of veterinary imaging, highlighting the area of cranial, spinal and abdominal equine imaging. Regular speaker at numerous courses, workshops and congresses of this specialty at an international level.

María Jesús Rodríguez Vizcaíno

Dr. María Jesús Rodríguez Vizcaíno obtained her degree in Veterinary Medicine and her PhD from the University of Murcia. She worked at the Equine Medicine and Surgery Service of the same University for 20 years, focusing mainly on general surgery, lameness investigation and diagnostic imaging, as well as emergencies. Dr. Rodriguez was also Associate Professor, participating in student teaching, supervising and collaborating in research projects. She is certified in Equine Orthopaedic Surgery by the Royal College of Veterinary Surgeons (UK) and is a specialist in Equine Sports Medicine and Rehabilitation by the ACVSMR. Since 2022, Dr Rodriguez has been collaborating regularly with the Equine Surgery Service of the University of Toulouse (ENVT, France) as an independent practitioner involved in general surgery, emergencies and lameness workup. She also collaborates temporarily with the Equine Service of the University of Castilla y León (Spain). She has numerous publications in national and international journals

and has participated with lectures, communications and posters in numerous national and international veterinary congresses and meetings.

José Manuel Romero

Jose Manuel Romero has a degree in veterinary medicine from the Complutense University of Madrid (1979). He has extensive experience in the diagnosis and treatment of musculoskeletal injuries in sport horses. He has been a veterinarian for the Spanish Olympic Team in Seoul 88 and Barcelona 92. He is a veterinarian of the Villa de Madrid Country Club and FEI Official Veterinarian in the disciplines of Jumping, Dressage and Eventing as well as Allowed Treating Veterinarian He is a diplomate of the American and European College of Sports Medicine and Rehabilitation and Certified Member of ISELP. He is the author of numerous scientific articles and book chapters and a regular speaker at national and international conferences.

Caterine Termine

Caterina joined the FEI in 2014 and is involved with a wide range of veterinary technical matters, including the production and delivery of Clean Sport education and information to the equestrian community. She also had a substantial role in managing the EHV-1 outbreak in Valencia during 2021. Prior to her current role, Caterina worked in equine practice and in equine biosecurity and infectious diseases research at the Animal Health Trust in the United Kingdom. She was also veterinary advisor for the Riding for the Disabled Association (UK), an FEI Veterinary Delegate at various Jumping and Eventing competitions and a Testing Veterinarian for her National Federation.

Emmanuel Van Erck

Dr Emmanuelle Van Erck - Westergren graduated from the Ecole Nationale Vétérinaire de Maison Alfort (France) in 1996. She did a PhD on respiratory functional tests in horses at the Veterinary Faculty of the University of Liege (Belgium). Her work led her to participate to research projects in Equine Sports Medicine at Cornell University (USA) and at Uppsala University (Sweden). These experiences triggered her passion for equine sports medicine. In 2000, she became Senior Consultant at the Centre for Equine Sports Medicine at University of Liège where she dealt with referred cases in sports medicine, participated to numerous research projects and collaborated to the training of veterinary students. In 2007, she was invited to develop the equine internal and sports medicine unit in the CIRALE in Normandy (France). Emmanuelle became a de facto diplomate of the European College of Equine Internal Medicine (ECEIM) in 2008 and was subsequently acknowledged as European specialist in Equine internal medicine by the Order of Veterinarians.; In 2010, she was invited to be a board member of the International Committee at the International Conference on equine Exercise Physiology (ICEEP), an internationally recognised organisation in Equine sports medicine. Emmanuelle is author of more than 40 scientific articles and regularly lectures at international scientific meetings. She is member of the board of the Belgian Equine Practitioner Society (BEPS) and on the scientific committee of the French Association of Equine Veterinarians (AVEF). She continues to collaborate to applied research projects in Equine Sports Medicine, to teach clinical training for the veterinary students and practitioners and to contribute regularly writing in both scientific and lay reviews. She was appointed Team Vet for Belgium in 2015 and was elected president of the Belgian Equine Practitioner Society (BEPS) in 2019.

Marta Varela

She has a degree in Veterinary Medicine from the Complutense University of Madrid (UCM) (1999) and working in equine ambulatory practice and sports medicine, mainly at La Zarzuela Racetrack (Madrid). PhD in Veterinary from the Complutense University "Horse races in Spain 2011-2014: characteristics and relation with the incidence of catastrophic musculoskeletal

injuries" (2016), she is also assistant professor of the Animal Medicine and Surgery Department (UCM Veterinary Faculty) since 2015. She was Head of the Equine Surgery Service of the Complutense Veterinary Teaching Hospital (HCVC), and since 2018 she is the Head of the Large Animal Area at the HCVC. Her principal interests include equine high-performance sports medicine (principally horseracing) and equine surgery.

Dominique Votion

Dominique-Marie Votion is researcher at the Fundamental and Applied Research for Animals & Health (FARAH) at the Faculty of Veterinary Medicine, Liege University (Belgium). She conducts research that aim at validating new tools for studying the pathophysiology of equine myopathies. In 2005, she has initiated the "Atypical Myopathy Alert Group" (AMAG), an informal European epidemio-surveillance network consisting of European equine veterinarians and researchers concerned by the condition. This European network aims to favour the quick diffusion of alert message from the scientific field to the equine sector thus favouring the setting of preventive measures edited from ongoing epidemiological investigations. Her interest for the muscle in healthy and myopathic horses includes the study of the mitochondrial function and since 2007, she is an active member of the Mitochondrial Physiology (MiP) society. She has validated the technique of high-resolution respirometry in horses that enables to monitor the mitochondrial respiratory function in small permeabilized muscle samples.

Eduard J. Cunilleras

Eduard José Cunilleras received his Veterinary Sciences degree from the "Universidad Autónoma de Barcelona" (UAB) in 1997. He was awarded a "la Caixa" Foundation 2-year scholarship for postgraduate studies and joined the Veterinary Teaching Hospital at The Ohio State University, where he completed a 1-year Internship in Equine Medicine and Surgery (1998) and a 3-year Residency program in Equine Internal Medicine. He became "Diplomate of the American College of Internal Medicine (subspecialty Large Animal Internal Medicine) in 2001. He undertook a PhD program in Veterinary Medicine, involving carbohydrate metabolism in exercising horses, being awarded his PhD degree in 2004. His postdoctoral studies were pursued at "The Animal Health Trust" in Newmarket, UK, where he joined the Equine Sports Medicine and Cardiorespiratory team lead by Dr. Lesley Young and Dr. Dave Marlin. In early 2006, Dr. José Cunilleras went on to develop his professional career as specialist in equine internal medicine at a private equine veterinary hospital (Donnington Grove Veterinary Group, Newbury, UK), and in early 2007 moved to Cliffe Equine Vets, Lewes, UK). In late 2008, he joined the Dept. of Animal Medicine and Surgery at the UAB as Assistant Professor ("Professor Lector") in Equine Medicine. In 2014, Dr. José Cunilleras became Associate Professor ("Professor Titular") in Equine Medicine at the UAB. Regarding research, he has a diverse scientific profile focused in two areas: equine internal medicine and infectious diseases, specifically inflammatory and coagulation disorders and infectious bacterial and viral conditions; and equine and comparative sports medicine, more specifically carbohydrate and lipid metabolism during exercise and fluid and electrolyte disorders. He is currently a member of the "Infectious and inflammatory diseases of companion animals" research group recognized by AGAUR-Generalitat de Catalunya. His research output has resulted in over 60 peer- reviewed research articles, most of them in journals of the top quarter within the Veterinary Sciences area, such as Journal of Veterinary Internal Medicine, Equine Veterinary Journal, Journal of Applied Physiology, etc. He has contributed with 8 bookchapters in renowned textbooks: Equine Internal Medicine (Reed, Bayly & Sellon), Equine Sports Medicine and Surgery (Hinchcliff, Kaneps & Geor) and Five-minute Veterinary Consult: Equine (Lavoie). He has presented over 80 abstract and posters at national and international conferences and has been invited to lecture at 8 national and international conferences (Congress of the European Veterinary Emergency and Critical Care Society, Congreso Iberoamericano de Asociaciones de Veterinarios

Especialistas en Équidos etc). He has participated in 7 publicly and privately funded research projects and 5 research contracts.

Inge D. Wijnberg

Inge D. Wijnberg, graduated in 1990 “with honor’s” as veterinarian at the University of Utrecht. Her H index is 24 and RG score 34.4. Her DVM degree included additional doctoral degrees for her almost one-year study program in the USA in 1988-1989. After working in private practice and a short period at the department of Immunobiology at the RIVM she started in 1995 as Resident Equine Internal Medicine at the Department of Large Animal Internal Medicine and Nutrition at Utrecht University. A three-month training under supervision of Professor Reef (University Pennsylvania, USA) in echography, echocardiography and cardiology was part of the trainee program in 1996. In 2000 she became RNVA Specialist Equine Internal Medicine. In 2002 she defended her PhD entitled “the diagnostic possibilities of EMG needle examination in the horse” and received the Doctor degree at UU in Veterinary Medicine. In 2003 a permanent position as assistant professor UU was obtained and in 2004 the registration as Specialist EVCS in the ECEIM register was a fact. Her focus in clinics are infectious diseases, cardiology, neuromuscular diseases and neonatology. She coordinated the Neonatal Foal Intensive Care Unit from 1996-2016. Until September 2016 she was chairman of the Bachelor program “Circulation” of the Faculty of Veterinary Medicine, Utrecht University. From 2003- 2016 she was (co)organizer of the Bachelor program “Clinical Reasoning and Clinical skills” Veterinary Medicine and member of the working group bachelor respiratory diseases and neurology. Other activities were member of the Education committee, Quality Committee for educational qualification, active member of the University Labour Representation Board, education Advisory Committee. She is a member of the ECEIM exam question writing group. She has been visiting professor at the University of Brno, Czech Republic and St George University Grenada West Indies, Buenos Aires and trained many specialists over the world in many international workshops and courses. She initiated and participated in several national and international research projects, occasionally involving other species and is Chief Specialty Editor for Frontiers in Veterinary Medicine Section Comparative and Clinical Sciences. With her as (co-) author over 80 scientific publications and over 40 congress abstracts have been published. She initiated and supervised three PhD tracts. Since September 2016 continues her UU work for 1 day per week and she participates in the emergency shift on a regular basis. In addition, she works fulltime as Senior advisor for the Coordination Expert Centre working circumstances and preventive health for the Ministry of Defence in the cluster (micro)biology and infectious diseases. Topics include Bioterrorism, transport hygiene, diagnostics field detection of infectious agents, and military working animals. In this position she is also active as representative expert for the Ministry of Defence in several NATO panels (FWSVS, C-IED MWD working group and BIOMED-P). She is governmental senior advisor for the MOD in the EDA CAPtech CBRN and HF. Other tasks are project management on research projects on bio- diagnostic, biodetection and outbreak management in cooperation with other (research) partners such as TNO, RIVM, and Biotrack.

SMALL ANIMALS PROGRAM:

KEYNOTE AND INVITED LECTURES

Elaboration of training programs: How to apply in our practice

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The world of canine sports, similar to human sports, involves a wide spectrum of disciplines, which can differ significantly. Obtaining results implies the need for training, specifically for physical conditioning. Training requires an intentional and systematic approach to conditioning, to achieve a desired goal. This contrasts with exercising, which usually refers to more or less sporadic physical activities, without the overarching planning and intentionality of training. While exercising will certainly bring beneficial health effects, it does not necessarily contribute to the overall goals and results of the canine athlete. In fact, it can even have a detrimental effect under some conditions. Overall, physical training aims to maximize function and prevent sports-related injuries. Depending on the source considered, athleticism is formed by different key components, present and being of interest in varying degrees according to the specific sport. The most commonly referred ones are strength, speed, power, agility, anaerobic capacity, aerobic capacity, mobility, balance and coordination, mental resilience, and stability (Tomlinson & Nelson, 2022). Despite the well-recognized benefits, proper physical conditioning is still an overlooked preparation area for the canine athlete or working dog, particularly in task-based sports/missions.

The best approach to training is to mimic the actual sport or activity as much as possible. Although it may sound obvious, this overarching principle is sometimes forgotten. The requirements for a dog involved in sled racing differ greatly from those involved in agility, flyball, or ring sports. In addition to a sports-specific component, which consists of practicing the exact movements required for a particular sport or activity, conditioning should include a certain level of cross-training. Cross-training involves training sport-related movement patterns with different loads. With that in mind, while following some guiding principles, programming is a very individual-specific process. In addition to specificity, overload is another principle that applies to all training programs, by which the intensity of the exercise must be above a certain threshold to induce physiological changes, such as an increase in VO_2 max or muscle hypertrophy.

Strength and power are required for all sporting dogs at different levels, regardless of their sport. Muscle hypertrophy, related to increased strength, usually takes 8-12 weeks, following a consistent program. Endurance is another requirement, referring to the physical capability to sustain an exercise for an extended period. It is usually used as a synonym for cardiovascular endurance, related to the ability of the heart and lungs to provide oxygen to tissues during exercise. Proprioception and balance are other components of a well-balanced program, as flexibility and agility also need to be worked on. Together, they improve core stability and decrease the risk of injury (U.S. Army Veterinary Services, 2019).

When prescribing training programs, emphasis should be placed on managing expectations and respecting the time required for sustainable adaptations. Not much information is available regarding determinants for exercise prescription and programming in dogs. For endurance, sessions are usually performed at submaximal levels, <80-90% of maximal effort, for at least 20-30 minutes, at a frequency of 4-5x/week, before reducing to a maintenance level of 3x/week (J.

Alves et al., 2012; J. C. Alves et al., 2020). Duration of individual sessions can be increased by 5-10minutes/session, over 1-2 weeks. Strength and flexibility exercises are usually performed at 8-12 repetitions, for 3-5 sets, around 3 sessions/week, at least 48 hours apart. A 2-10% load increase can be increased after two comfortable sessions of comfortable performance. A wide range of exercises can be selected, according to needs and preferences. The Penn Vet Working Dog Center has developed a formalized method for the development of physical fitness, the Fit to Work Program, which is an excellent reference when establishing a well-balanced program (Farr et al., 2020).

Two major components that need to be incorporated in all training programs, which can be overlooked, are nutrition and recovery. Proper nutrition must be established to meet the body's sustained development and maintenance requirements. Nutrition to recovery between training/working sessions. Rest, including "non-activity" and active recovery needs to be formally included in all training plans. Many trainers/handlers will be tempted to overdo physical training, as most animals will show a good and fast response, particularly in the early stages, and because they are keen on seeing results. It is also paramount to align physical training programs with the working/sporting calendar, as peak performance is not sustainable. Trying to maintain this stage indefinitely will, ultimately, lead to underperformance and injury.

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Unveiling canine aging: exploring postural stability changes, measurement techniques, and implications for physiotherapy

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Postural control:
Walking and standing should not be viewed as simple, cognitively independent functions. Physiological movement requires a complex interplay of cognitive and motor functions. Postural control – the process of maintaining, achieving, or restoring a state of balance during posture or activity – plays a crucial role. It forms the basis of many everyday activities, maintaining the body's balance both at rest (static balance) and in motion (dynamic balance). This is achieved through a complex interaction of the central nervous system with the three main systems responsible for balance: the visual, somatosensory, and vestibular systems. Together, these systems control the posture-stabilizing muscles of the legs and trunk, enabling almost instantaneous responses to balance disturbances. If a patient struggles to maintain, achieve, or restore equilibrium, they have a deficit in postural control, which can result from various cognitive, sensory, or motor impairments. Increasing postural instability indicates decreased neuromuscular control, as seen in aging or various diseases, including Alzheimer's disease.

Measurement techniques:
In biomechanics, the Centre of Pressure (COP) is the point where the force acts on the ground (the application point of the force). The ground reaction force (a vector) represents the sum of all forces between a physical object and its contact surface. Displacement of the COP is an indirect measure of the functionality of postural control and thus a measure of the ability to maintain balance. Even when standing still, the human body constantly moves in the anterior-posterior and medial-lateral directions: small muscle contractions maintain an upright position. Accordingly, the body's center of gravity (Centre of Mass, COM) and the COP under the feet continue to move even when a person is supposedly standing still (1). The natural oscillation of the COP can be measured using a force plate and represented mathematically. Posturography, a comprehensive tool for the objective and sensitive analysis of postural control, is the gold standard for laboratory measurement of posture control in both healthy and diseased individuals (2).

Aging and COP:
In humans, it has been demonstrated that, for example, musculoskeletal disorders (3) as well as the aging process (4) can lead to impairments in postural stability (PS). The initial results on postural stability (PS) in aged animals (5) indicate, similar to findings in humans (4), that the aging process also leads to impairments in PS.

Implications for physiotherapy:
Even though relatively few scientific findings exist on the importance of postural stability (PS) in dogs, these findings support the now common practice of using active therapeutic exercises that challenge the animal's balance in physical medicine and rehabilitation, both for young animals and for those that are sick and/or old. The rationale behind this approach is, on one hand, to improve body control through balance training in young animals to prevent injuries, and on the other hand, to train the joint-stabilizing muscles and promote PS impaired by musculoskeletal diseases (6).Additionally, a training program that includes proprioceptive challenges is recommended for older animals to maintain a good quality of life (7). Traditional training devices,

such as wobble boards and proprioception cushions, can be used effectively and cost-efficiently by both therapists and pet owners.

However, motorized platforms offer the advantage of controlled, reproducible movements that can be directly tailored to the needs of the animal. Their movements combine rotational, lateral, and cranio-caudal components, allowing direction, speed, and amplitude to be altered in a controlled manner. This creates external, mechanical perturbations intended to challenge balance similarly to a multidirectional wobble board. These external mechanical perturbations on motorized training devices cause a significant increase in COP parameters even in healthy, adult dogs. It can thus be concluded that this training device poses a challenge to the balance of dogs. Among the tested settings, the displacement of the training device has a significantly greater impact than the speed of the movements. Therefore, it is recommended to initially challenge severely geriatric, orthopaedic and/or neurologically impaired animals by increasing the speed with a low displacement (8).

Conclusion:
Postural control is a complex interplay of cognitive and motor functions crucial for maintaining balance in humans and animals. Aging and musculoskeletal disorders impair postural stability, necessitating therapeutic interventions. Traditional training devices are effective and cost-efficient, but motorized platforms offer tailored, controlled movements that challenge balance effectively. The use of motorized platforms significantly impacts canine balance, suggesting their potential in therapeutic settings. Future research should explore the long-term effects of motorized platform training on postural stability in animals, with a focus on optimizing training protocols for geriatric, orthopedic, and neurologically impaired individuals.

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Rehabilitation in the neurology patients: new tendencies

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The intensive functional neurorehabilitation concept emerged in the field of human medicine, based on electrical stimulation programs, modalities such as laser therapy, in association with repetitive exercises, aiming to achieve a positive evolution and clinical success. This approach, in the perspective of one health, should be translated for dogs and cats in both compressive or non-compressive myelopathies.

In dogs, the most common spinal cord injury (SCI) disorder is the intervertebral disc disease (IVDD), which is present in 74% of all acute and severe cases of SCI, resulting in disability or even euthanasia.

Thus, severe SCI are associated to patients classified as grade 0 or 1, according to the modified Frankel scale (MFS), with the absence or presence of deep pain perception (DPP) as a prognosis indicator. Deep pain perception is transmitted by small diameter axons encompassed in the multi-synaptic bundles, that is on the spinoreticular tracts, on the propriospinal tracts and possibly on the spinothalamic tracts.

In these severe SCI, there is a massive destruction of the medullar parenchyma, although there may be some maintained axonal connections, which are targeted for measures with therapeutic potential. Some authors suggested that it could be possible an interconnection between residual motor descending tracts and motor intrinsic interneurons circuits, later responsible for a flexion-extension motor pattern, which may allow the spinal reflex locomotion.

Protocols of intensive functional neurorehabilitation intend to explore synaptic and anatomic neuroplasticity, aiming neuromodulation based on task-specific repetitive training, functional electrical stimulation and laser therapy modalities to improve functional outcome, ambulation and quality of life for MFS 0/1 dogs and cats.

To the neuro-rehabilitator it is important to identify cases with the presence of clinical signs compatible with spinal shock syndrome and progressive myelomalacia. In these situations, it´s urgent the need for early introduction of functional electrical stimulation and transcutaneous electrical stimulation of the spinal cord, as well as the underwater treadmill training (24h to 7 days), that may lead to recovery.

Also, locomotor training based on the body weight supported treadmill applied on paraplegic deep pain positive dogs (MFS1) with spinal shock signs secondary to acute thoracolumbar IVDD by extrusion, was shown to be safe, repeatable and a useful tool to promote better functional outcome in less time.

Cardiac rehabilitation in veterinary patients

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Cardiac rehabilitation for dogs and cats is a common situation in the clinical setting. Most programs are related to the one health perspective, which is a collaborative effort of multiple health science professionals that aim to obtain optimal health for people, domestic animals, wildlife, plants and environment.

Thus, exercise intolerance, chronic fatigue and inability to perform daily activities are the most common demonstrations of heart failure. The reasons for all these clinical signs are multifactorial due to central and peripheral mechanisms. There are complex interconnections between HF and tissue perfusion deficits associated with obesity, increase in blood pressure and chronic inflammatory stages.

The physiological mechanisms under the beneficial effects of cardiac rehabilitation are related to the improvement of: respiratory muscle strength and dyspnea; cardiac output and resting heart rate; decrease of sympathetic tone with increase vagal tone; decrease renin, angiotensin and aldosterone; decrease in inflammatory cytokines; decrease in hyperlipidaemia; decrease in insulin resistance and adiposity; decrease in sarcopenia; improve fiber composition; decrease in hypertension and vasoconstriction.

Cardiac rehabilitation needs constant exercise monitorization, with medication re-evaluations regarding dosing and frequency, with possible resort to telemetry, which gives continuous heart rate (HR) and blood pressure. This rehabilitation may include aerobic training, which upregulates the VO2 peak.

In the clinical setting, this type of cardiac patient should perform quadrupedal locomotor training in the land treadmill but in case of muscle fatigue with increase HR, this could be replaced by bipedal locomotor training. Electrocardiogram (ECG) should be performed before and after every session of aerobic training, and if the HR increases nearly 50%, next training should have a 50% decrease in velocity and time duration.

Regarding rehabilitation modalities, functional electrostimulation (FES) is a modality that can increase muscle strength, with less hertz (Hz) and milliamperes (mA), depending on the patient's comfort. As for the laser therapy, ultrasounds and diathermy, all could be applied as long as vasodilation is controlled to avoid decrease of blood pressure and cardiac injection stress, which could lead to arrythmias.

The rehabilitation should have knowledge in ECG interpretation, being able to identify atrial fibrillation, idioventricular rhythm, supraventricular tachycardia and ventricular tachycardia.

One other possibility is the use of underwater treadmill, with careful decrease in water temperature, also to avoid possibility of cardiac decompensation and syncope. These syncopal episodes can be associated with several types of arrythmias (e.g. sinus arrest, ventricular tachycardia, sick sinus syndrome, third degree atrioventricular block) and, in small breed dogs, with advanced myxomatous mitral valve disease.

In cases of HR variability, this should also be monitored by Holter system to detect severe bradycardia (> 4 successive sinus complexes with HR<45 bpm), atrial premature complexes (APCs), severe supraventricular tachycardia (> 3 APCs with HR >150bpm), sinus tachycardia (>3 sinus complexes with HR>150bpm), ventricular premature complexes (VPCs) and ventricular escape complex.

This could help in cardiac stabilization, adapting pharmacological medication and aerobic training to the need and comfort of the cardiac patient.

Rehabilitation of atypical cases in the neurology patient

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There are several advances in rehabilitation mostly in intervertebral disc disease (IVDD) by extrusion, in association with body conformation and biomechanics alteration of some breeds, such as the Dachshunds French bulldogs and Pekingese, likely reflecting the influence of the FGF4 retrogene on chromosome 12 and 18.

Thus, in acute thoraco-lumbar IVDD, is important for the neuro-rehabilitator to know if there was evidence of epidural haemorrhage due to laceration of internal vertebral venous plexus, leading to continuous multilevel spinal cord compression. In these situations, patients should go through a rigorous neuro-rehabilitation exam with the worst prognosis and the need for a larger period of rehabilitation. This phenomenon of disc extrusion with extensive epidural haemorrhage (DEEH) is an example of an atypical and difficult case to rehabilitate.

Furthermore, IVDD by protrusion is usually observed in older non-chondrodystrophic dogs that have a degree of disc fibrosis, frequent cases of disc-associated cervical spondylomyelopathy and degenerative lumbosacral stenosis. These specific cases are difficult to handle, mostly when dogs have tetraplegic presentation and weigh more than 25 kg, with a major need for a multidisciplinary team support.

In addition, patients that suffer from spinal shock syndrome, with sudden loss of sensory motor function after acute severe spinal cord injury or spinal cord transection, have hindlimb reduced reflexes typical of L4-S3 neuroanatomic location, although it may also be present in T3-L3 myelopathies with this syndrome. These spinal shock dogs need early stimulation of reflexes to achieve recovery.

Locomotor training has a major role for all these patients and early underwater treadmill training integrated in a multidisciplinary protocol can be a tool for maximum stimulation in spinal shock dogs. Exercises are a strategy to stimulate interaction between afferent inputs from proprioceptive and biomechanical receptors of the intrafusal fibers, hip joints, other joints and skin. This early training is a source of stimulation that improves glutamatergic input with activation of muscle fibers, proprioceptors and interneural networks. Combination of spinal shock with absence of deep pain should be interpreted with caution, maintaining stability of the spinal cord. In dogs with acute non-compressive nucleus pulposus extrusion, it was suggested that the presence of spinal shock had a negative influence on the neurorehabilitation, delaying time until complete recovery.

Therefore, intensive neurorehabilitation protocols are crucial for this critical population of dogs. These protocols are carried out 5 to 6 days/week and include electrical stimulation (e.g. Interferential - Transcutaneous electrical nerve stimulation, Transcutaneous electrical stimulation of the spinal cord, functional electrical stimulation (FES)), laser therapy (for pain and regeneration) and locomotor training (land, underwater treadmill (UWTM), kinesiotherapy, obstacle rails, gait stimulation in different floors, balance board exercises and others).

Supportive care of these patients is also important and includes hydric maintenance (100-150 ml/kg of water intake) and nutritional support (30-50% increase in the rest energy requirement). Additionally, manual expression of the bladder (3-4 times/day) with urine monitoring is needed

and passive range of motion exercises followed by massages that should be performed at the end of the day.

Lastly, in cases of peripheral nerve injury, that are always a challenge, FES has an important role and is usually implemented on the anatomic pathway of the radial nerve (one electrode placed in the region of C6, C7, C8, T1, T2 and the other placed in the motor point of the triceps brachialis muscle). This technique followed by the application of a corrective splint for 2 hours twice a day could be the key to avoid joint contractures. After the 4th week of rehabilitation, there is the introduction of locomotor training with assisted active exercises (2 times/day, 6 days/week), which could be performed in the UWTM for 10 min with rhythmic bicycle movements, followed by cavaletti rails. An increase in the difficulty of the training could be achieved after 6 weeks, adding 10% slope on the land treadmill.

Consequently, the neuro-rehabilitator, the neurosurgeon and the neurology veterinarian specialist have to extensively cooperate in these difficult cases in order to obtain recovery.

Difficult cases need early intensive neurorehabilitation protocols and time to improve. The moral of the story is not to give up.

Acupuncture: evidence and how can help to our rehabilitation patients

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Acupuncture, an integral component of Traditional Chinese Medicine, is gaining increasing recognition within evidence-based medicine for its potential applications in rehabilitation.

Recent studies have demonstrated the positive impact of acupuncture on pain management, functional improvement, and potentially neurological rehabilitation. In feline patients, laser acupuncture exhibits comparable analgesic efficacy to electroacupuncture in ovariohysterectomy procedures (Nascimenta et al., 2019). A scoping review of the evidence for the efficacy of acupuncture in companion animals concluded that it is likely effective and safe, although it highlighted a lack of rigorous studies and identified numeorous studies reporting no effect of acupuncture (Rose et al., 2017). Notably, an earlier systematic review by Habacher et al. (2006) analyzed 31 controlled trials and found mixed results, with some studies reporting positive effects while others did not, ultimately concluding that there was no compelling evidence to either recommend or reject acupuncture for any specific condition in domestic animals at that time. However, a more recent review focusing on the scientific basis of acupuncture for veterinary pain management over the last two decades suggests growing evidence for its effectiveness in various pain conditions (Dewey and Xie, 2021).

In animal models, acupuncture has demonstrated the ability to modulate pain responses and regulate physiological functions.

The mechanisms underlying acupuncture's therapeutic effects remain an area of ongoing investigation. However, several potential mechanisms have been proposed, encompassing the following:

- Endorphin release: Acupuncture is hypothesized to stimulate the release of endogenous opioids, contributing to analgesia and mood elevation.
- Neuromodulation: Acupuncture may influence the activity of neurotransmitters and neuropeptides, affecting pain perception, inflammation, and motor function.
- Microcirculation enhancement: Increased blood flow and oxygen delivery to injured tissues can promote healing and tissue repair.
- Anti-inflammatory effects: Acupuncture may exert anti-inflammatory actions through the modulation of various molecular pathways.

In conclusion, acupuncture represents a promising adjunctive therapy in the rehabilitation setting. While some studies have reported no significant effect, other suggest acupuncture's potential in managing pain, improving function, and possibly facilitating neurological recovery. Continued research is crucial to further explain its mechanisms and optimize its application, warranting its consideration as a valuable tool in the rehabilitation.

RESIDENT FORUM: ABSTRACTS

Is Kinesiotape useful to correct space in canine species?

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Background: The Kinesio Taping Method is believed to relieve pain through neurological suppression. It creates more space under the skin improving blood and lymph flow by eliminating extra fluid, edema or bleeding beneath the skin.

Objectives: The present study aimed to investigate the immediate effects of Kinesio Taping on surrounding soft tissues of the canine hip when measured by diagnostic ultrasound.

Material and Methods: Eleven healthy medium-size short-hair dogs (n=22 hips) were recruited.

Two standard 6 cm wide VetkinTape® strips I-shaped (75-100% of available tension) were attached dorsally and ventrally around the area of the greater trochanter from the dorsal rim of the iliac crest to the popliteal surface. Dogs were placed in lateral recumbency with the limb in a neutral position (the femur parallel to the table with 90º angle of hip and stifle flexion). Three ultrasound measurements were performed at each hip before and immediately after the kinesiotape was placed: the distance from gluteus medius deep fascia perpendicular to the probe, the distance between the dorsal acetabulum rim (on the femoral head intersection) and the probe, and the distance between the femoral head base (next to the trochanter) and the probe.

Results: There were no statistically significant differences between pre and post kinesiotape ultrasound evaluation for none of the three measures (ANOVA; $p>0.05$). However, echogenicity changes were observed in the adjacent tissues around the joint capsule.

Discussion/Conclusion: There are no studies to our knowledge that analyze the efficacy of this technique in the canine species. Comparing our results with those obtained in human, we didn´t observe differences by an ultrasound evaluation. Further studies must be carried out by other diagnostic methods to assess other parameters that demonstrate its effectiveness in dogs.

Declare conflicts of interest or state “The authors declare no conflict of interest.”

All owners signed a detailed informed consent, and these interventions were considered non-invasive clinical practice by the institutional Institutional Review Board (or Ethics Committee) of University of Extremadura.

“This research received no external funding”

ORAL COMMUNICATIONS: ABSTRACTS

Multimodal contextualized approach to dogs with fibrotic myopathy

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Background
Non-invasive medical treatments and rehabilitation modalities of fibrotic myopathy in dogs involve a multimodal approach including instrumental physical therapy, manual techniques, hydrotherapy and therapeutic exercises.

Methods
Two working German Shepherd dogs and a German Shepherd crossbreed dog diagnosed with fibrotic myopathy have been considered. A complete multimodal approach including laser therapy, therapeutic ultrasound, massage, stretching, myofascial release, functional exercise, dry needling and water treadmill hydrotherapy has been prescribed to all patients. The initial phase involved weekly sessions, shifting to every 2-3 weeks and monthly maintenance treatments in the mid to long-term. The actual treatment received by each dog has been adjusted and contextualized considering the individual situation; logistics and financial decisions of the owners influenced the therapeutic plan acceptance.

Results
One working dog initially received intensive treatment, and successfully returned to usual exercise, then complying with a maintenance program and a positive follow-up 48 months since diagnosis.

The crossbred patient's owner only committed to laser therapy and myofascial release every fortnight, in addition to home exercise, showing progressive improvement in 2 months and a positive follow-up 24 months since diagnosis.

The other working dog only received local laser therapy treatment on the diagnosed lesion due to both owners' lack of commitment and patient's behavioral issues, nevertheless showing improvement of the palpatory examination of the affected muscle groups after 4 treatment sessions.

Conclusions
Contextualization and adaptation of a multimodal treatment plan up to different levels of owners' and patients' compliance, can lead to satisfying outcomes in management of fibrotic myopathy.

Conflict of interest declaration: "The authors declare no conflict of interest."

Ethical Committee: Not applicable due to the study being a description of the contextualised adaptation of therapeutic approach to the same pathology, in form of case reports

Sources of funding: This research received no external funding

Surface Electromyography of the Lateral Triceps and Biceps Brachii Muscles in Dogs During Selected Therapeutic Exercises

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Background and Objectives

Electromyography (EMG) has been used to assess muscle activity. The purpose of this study was to assess EMG activity of the lateral triceps (LT) and biceps brachii (BB) muscles while performing exercises.

Materials and Methods

Eight normal dogs free of gait asymmetry were included. Wireless electrodes were attached to the midpoints of the LT and BB of the left forelimb.

EMG amplitude was determined at a stance and values were normalized to 100%. Static exercises included balance board standing, elevation of the hindlimbs on a platform, and elevation of the hind limbs on a platform with the forelimbs on an inflatable disk. Dynamic exercises included stepping up and over a platform, wheelbarrowing, walking, and trotting. EMG data were filtered, rectified and smoothed. ANOVA and paired t-tests were used to evaluate data.

Results

Maximum EMG amplitude of the TB and BB was significantly higher for all exercises when compared to a stance except for TB with elevation of the hindlimbs. Mean EMG amplitude of the TB and BB was significantly higher for dynamic exercises compared to a stance, but static exercises were not different from stance. Wheelbarrowing increased the mean amplitude of both the TB and BB the greatest.

Discussion and Conclusions

The results of this study may help in the selection of exercises to engage the TB and BB muscles during rehabilitation. Future studies should include evaluation of other forelimb muscles, comparison of fine wire and surface EMG activity, and evaluation of muscles during other exercises.

Conflict of interest declaration: “The authors declare no conflict of interest.”

Ethical Committee: The study was approved by the Institutional Care and Use Committee.

Sources of funding: This research was funded by the Veterinary Orthopaedic Laboratory at the University of Tennessee College of Veterinary Medicine

Enhancing Veterinary Sports Medicine: Thermographic Patterns in Athlete Dogs

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Thermography detects surface temperature variations, revealing physiological alterations before clinical signs, crucial for monitoring injuries and to verify whether the rehabilitation effectively stimulates the affected areas.

The objective of this study was to establish the thermographic pattern in athlete dogs discerning thermal differences between contralateral body parts compared to healthy counterparts.

1065 regions of interest (ROIs) belonging to 148 dogs were examined, 46 of them athletes competing in agility. Images were acquired using a Fluke Ti125 camera. The images were set on full infrared and the high contrast palette through. An image taking protocol was established. Statistical analysis was carried through a comparison of means with an ANOVA, performing Scheffé type post hoc tests, establishing a significance level of $p<0.05$.

Results revealed symmetrical thermal patterns in healthy and athlete dogs, albeit with greater variability among athletes ($p<0.001$).

Diagnostic criteria were established using receiver operating characteristic (ROC) curves, indicating in healthy canines a temperature difference of 0.45°C between contralateral body parts and 0.7°C for athletes.

The study reaffirmed findings from prior research, suggesting a temperature difference exceeding 0.5°C between contralateral body parts as indicative of pathology in canines. However, athlete dogs exhibited wider thermal variations, necessitating an expanded acceptable difference of 0.7°C, likely attributed to training adaptations.

This study's findings underscore the importance of tailored diagnostic criteria for different populations, such as athlete dogs, to enhance thermographic evaluations in veterinary practice.

Conflict of interests: The authors declare no conflict of interest.

Ethical Committee: As it is a non-harmful and non-invasive procedure, the Consellería de Agricultura, Medi Ambient, Emergencies Climàtiques i Transició Ecològica authorizes the study if informed consent is presented from the animals' guardians.

Sources of funding: This research received no external funding.

Factors associated with falling from the dogwalk in agility dogs

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Background: Falling from dogwalk obstacle has been associated with injuries in agility dogs, but the risk factors related to it have not been reported.

Objectives: This study evaluated incidence of falls and risk factors for falling off the dogwalk.

Material and methods: Owners of 991 Finnish agility dogs answered a survey regarding dogwalk falls within a six-month period. Evaluated risk factors included dog's age, size, breed, experience and performance technique on dogwalk as well as experience of the handler. Number of dogwalk performances was additionally estimated. Complete data was available for 950 dogs. Each factor was first evaluated in univariate logistic regression model. Factors with $p<0.1$ were included in the development of final multivariate model using backward selection.

Results: Fifteen percent of dogs had fallen off the dogwalk and 4% of dogs had suffered an injury associated with fall or a close shave on the dogwalk. In the final model, age ($p=0.041$, OR 0.90 per year) and height ($p=0.002$, OR 1.03 per cm) of the dog were associated with odds of falling when controlled for number of dogwalk performances. Additionally, competition level of the dog was associated with falling ($p=0.009$) with dogs who have not competed in agility having higher odds of falling.

Conclusion: Inexperinced, young and tall dogs are at increased risk of falling from the dogwalk and could be at higher risk for injuries associated with falling.

Conflict of interests: "The authors declare no conflict of interest."

Ethical Committee: The study was approved by the Research Ethics Committee on Animal Research of the University of Helsinki (statement 4/2022, date April 2. 2022)

Sources of funding: This research received no external funding.

Technique for subcutaneous adipose tissue extraction from cranial to the manubrium to produce autologous mesenchymal stem cells and clinical outcome in 39 dogs

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Objectives:
To report the technique for subcutaneous adipose tissue extraction from cranial to the manubrium to produce autologous mesenchymal stem cells in dogs. Report the advantages and disadvantages of this approach based on the clinical implications and complications encountered.

Materials and Methods:
Hospital records from April 2021 – April 2024, of patients from one veterinarian, were searched for dogs that met the inclusion criteria. Data recorded included: signalment, reason to use stem cells, complications of adipose-harvest, and any concurrent procedure performed.

Results:
39 dogs met the inclusion criteria. Complications were reported in 3 patients. Two dogs had self-resolving seroma; and one dog had a superficial surgical site infection that required topical antibiosis. Stem cells were used to treat elbow joint arthrosis in 36 patients; stifle arthrosis, hip arthrosis, and hock arthrosis were treated in one patient respectively. Adipose tissue harvest was performed at the time of medial elbow surgery in 30 dogs (27 elbow arthroscopy, 2 sliding humeral osteotomy, 1 canine unicompartmental elbow replacement).

Conclusions:
Subcutaneous adipose tissue can be harvested from cranial to the manubrium to produce autologous mesenchymal stem cells with minimal complications in dogs and is especially useful for patients concurrently undergoing a medial elbow procedure (such as arthroscopy) as no change in patient positioning is required. Dogs are unable to lick or scratch this region reducing the risk of self-inflicted trauma and making the need to wear an Elizabethan collar obsolete.

Conflict of interests: "The authors declare no conflict of interest."

Ethical Committee: This report retrospectively describes cases that were managed as part of the hospital's routine clinical caseload; therefore, ethical approval was not required. Owner consent was given for all aspects of patient care.

Sources of funding: No funding provided.

Transcutaneous electrical spinal cord stimulation in deep pain negative dogs with thoracolumbar intervertebral disc extrusion – A controlled pilot study

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Background: Thoracolumbar intervertebral disc extrusion (TL-IVDE) dogs may present loss of voluntary micturition, which has a negative impact in their quality of life and owners.

Objectives: The aim of this prospective, blinded and controlled study was to verify if transcutaneous electrical spinal cord stimulation (TESCS) may improve bladder voiding within less time and decrease UTI, comparing to manual expression of the bladder, with/without tamsulosin.

Material and Methods: 58 TL-IVDE dogs, deep pain negative, were randomized in: GA-standard manual expression (n=15); GB-tamsulosin plus manual expression (n=20); GC-TESCS bid (n=23), followed by manual expression within 10 min. TESCS with 40 Hz, until 100 mA, electrodes at L2 region and the dorsal crest of the iliac wing. At admission (T0) all were monitored for urine analysis type II and bladder point of care ultrasound (POCUS). The same in T1 (15 days) and T2 (30 days).

Results: Regarding urine analysis type II, parameters decreased in both GB and GC, whereas POCUS findings revealed improvement, mainly, in GC. There was a significant difference regarding time for voluntary micturition between groups, with less time (p=0.002) and less UTI at T2 in GC (p=0.013).

Discussion: TESCS presented better results regarding early bladder voiding (p=0.002), with less UTI compared to the other groups (p=0.013), reducing the negative complications of neurogenic bladder as mentioned in the literature[1] and the need to place a urinary catheter[2]. Also, differing from the literature[3-5], our results in GC, presented less time with nearly 50% recovering voluntary micturition within 15 days and a total of 70% within 30 days.

Conflict of interests: "The authors declare no conflict of interest."

Ethical Committee: The study was approved by the Ethics Committee of Lusofona university (CEBEA) (protocol code 114-2021)

Sources of funding: This research received no external funding

Conservative treatment of post traumatic spinal fracture and subluxation in a cat: a case report.

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Exogenous trauma causing vertebral fracture, luxation and subluxation is an important cause of acute spinal cord injury in cats. Treatments of spinal trauma can be surgical and nonsurgical. Whether to use either or both, depends on numerous factors, including nonmedical ones such as the treatment costs. This case presents the synergy of several techniques to conservatively manage an acute spinal cord injury, whilst containing costs and avoiding euthanasia. A 1-yr-old, female neutered European shorthair cat was presented to the clinic after being attacked by dogs. Consequently, she could not move both hind limbs. At the physical examination the cat appeared in alert, in lateral decubitus, with bite wounds on the back. She presented paraplegia, absence of proprioception on the hind limbs, no deep pain, no spinal nerve's reactions. Flexor reflex was present but weak only on the right hind limb. Absence of deep pain and no voluntary movement of the tail were also observed. The x-rays showed: fracture of caudal articular facet of T13, subluxation of T13-L1. The owner did not allow further investigations, so the cat was initially hospitalized to control the pain, heal the wounds and keep her contained with a custom-made brace. She was also catheterized. A physiotherapy protocol was immediately planned with manual therapies, then implemented with laser therapy, neuromuscular taping and acupuncture according to traditional Chinese medicine. The evolution was followed up using x-rays and physiatric assessments during the year. The cat achieved spinal walking, independent urination and defecation and excellent life quality.

Conflict of interests: The author declares there is no conflict of interest.

Ethical Committee: The ethics committee for animal experimentation does not require ethics approval for routine diagnostics. Written informed consent was obtained for the anonymized patient information to be published.

Sources of funding: This research received no external funding.

Retrospective Evaluation of Treatment Outcomes for Sesamoid Disease in Dogs: 2018-2022

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Background and objectives
Sesamoid disease (SD) is a degenerative disease in dogs. The aim of this research is to review demographics and compare treatment outcomes in dogs with SD.

Material and methods

Records from 114 dogs diagnosed with SD at a private referral practice were reviewed for demographics, treatment and follow-up.

Results

Labrador retriever, Springer spaniel, and Cocker spaniel were the most represented breeds. In 76/114 dogs the only affected sesamoids were metacarpophalangeal 2 and 7. Right metacarpophalangeal sesamoid 2 was affected significantly more often in females than in males (18/52 vs 10/62; p=0.022). In all dogs with comorbidities (n=61), SD was subclinical and considered an incidental finding. Dogs with comorbidities were significantly older (p=0.013) and heavier (p=0.019). Management in dogs without comorbidities was surgical (3/53), conservative (37/53) or expectative (13/53). Conservative treatment was either monotherapy (21/37) or combination therapy (16/37). Follow-up was available for 39/53 dogs. Full and partial recovery were observed significantly more often than no improvement (34/39 vs 5/39; p=0.005). Recurrence of lameness was observed in 11/39 dogs. None of dog and treatment characteristics were significantly associated with full recovery or recurrence of lameness.

Discussion and limitations

Our findings are contradictory with previously reported most affected breeds being Greyhounds and Rottweilers. Our study supports that SD either results in thoracic limb lameness or is an incidental finding. The right metacarpophalangeal sesamoid 2 was affected significantly more often in females, which has not been reported before.

Limitations to this study are its retrospective design, and lack of standardized follow-up.

Conclusions

This study demonstrated a higher incidence of SD in Labradors, Springer Spaniels, and Cocker spaniels than previously reported. The results show that neither surgical nor conservative management is significantly associated with full recovery or recurrence of lameness.

Conflict of interests: “The authors declare no conflict of interest.”

Ethical committee: This study involved the use of nonexperimental animals only and followed internationally recognized high standards (‘best practice’) of individual veterinary clinical patient care. Ethical approval from a committee was therefore not necessarily required.

Sources of funding: This research received no external funding.

POSTERS: ABSTRACTS

Prevalence of genetic YARS2 mutation inducing cardiomyopathy and juvenile mortality in physically active Belgian Shepherd dogs

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Nowadays an increasing number of Belgian Shepherd (BS) dogs are involved in working and sport activities (IGP-International Utility Dog trial regulations, canicross, bikejöring, obedience, agility).

The aim of this pilot study was to evaluate in a group of BS sporting dogs the prevalence of YARS2 mutation, an autosomal recessive genetic disease identified as a clinically relevant but still little-known cause of cardiomyopathy and juvenile mortality (CJM) in BS.

Clinically affected dogs present a homozygous positive (P/P) genotype, while dogs with heterozygous negative/positive genotype (N/P) become carriers. Offspring generated by two heterozygous subjects display a percentage of distribution of 25 % non-affected, 25 % affected subjects and 50 % carriers.

Forty-eight BS dogs were tested for the presence of the mutation. Two samples were collected from each dog using mouth swabs. Our population was represented by 25 females and 23 males, median age of 44 months (range 1-177). Breed varieties included 25 Malinois, 13 Groenendael, 10 Tervueren.

Positive genetic mutation was found in 6 Malinois (12.5%), and all the positive were N/P heterozygous subjects. They were 3 females and 3 males, which generated a total of 9 puppies and were dogs active in IGP-International Utility Dog trial regulations, and canicross.

This study suggests that YARS2 mutation represents a real underestimated anomaly in BS dogs. Since transmitting the high-performance genetic traits of these athletic dogs is often the ultimate goal of the breeders, special care should be directed toward an overrepresented risk of YARS2 mutation transmission to the offspring.

Conflict of interests: “The authors declare no conflict of interest.”

Ethical Committee: No ethical approval was obtained because this study did not involve a prospective evaluation, did not involve laboratory animals, and only involved non-invasive procedures.

Sources of funding: This research was funded by A.Me.S.V.I. - Associazione Medico Sportiva Veterinaria Italiana (Italian Veterinary Sports Medical Association)

Management of chronic pain with scalp (YNSA) and tail acupuncture in hip osteoarthritis in a dog. Clinical Case

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Backgrounds

Osteoarthritis (OA) is a progressive degenerative disorder affecting synovial joints, characterized by chronic pain and inflammation of varying intensity, accompanied by structural and functional deterioration of the joint. Multimodal approaches are recommended for pain management.

Materials and methods

Spayed male dog with a body condition score of 6/9, presenting radiographic signs consistent with bilateral hip OA and pain upon palpation of both hips, was assessed. Pain was evaluated using the Canine Brief Pain Inventory (CBPI), with initial scores of 29/40 for pain description, 37/60 for function description, and an overall impression of good. Four sessions of scalp YNSA (Yamamoto New Scalp Acupuncture) and tail acupuncture were conducted at weekly intervals. Stimulating D points on the scalp and reactive points on the first third of the coccygeal vertebrae. 0,15 x 0.20mm needles were encouraged for scalp and tail. The treatment duration was 30 minutes. One week after the fourth treatment, CBPI scores improved to 18/40 for pain description, 21/60 for function description, with an overall impression of very good.

Conclusions

In this clinical case, the use of scalp (YNSA) and tail acupuncture at the selected points proved effective in managing chronic pain associated with hip OA. Study limitations include those inherent to being a single case study. Further clinical trials involving a larger sample size are needed to evaluate the efficacy and benefits of incorporating this technique.

Conflict of interests: “The authors declare no conflict of interest.”

Ethical committee: Not applicable so it´s just a one clinical case

Sources of funding: This research received no external funding.

Successful physiotherapy management of a geriatric dog who underwent femoral head and neck ostectomy and contralateral limb amputation

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Objective: To report the first physiotherapy management and mid-term outcomes of femoral head and neck ostectomy (FHNO) performed in a geriatric dog with pelvic contralateral limb amputation.

Material and methods: A 10-year-old dog was referred to our university hospital for physiotherapy. The dog had undergone right femoral head and neck ostectomy (FHNO) due to end-stage hip osteoarthritis and was experiencing pain and difficulty moving without support. The left hindlimb was amputated a year ago because of a highly comminuted irreducible femoral diaphyseal fracture. The radiographs performed before FHNO showed L5-L6 intervertebral disc degeneration and T9-T10 spondylosis deformans. Total hip replacement was not an option because of financial reasons.

The physiotherapy protocol consisted of weekly hydrotherapy sessions to promote muscle growth and strength, zonal laser therapy to manage joint pain, systemic analgesic nonsteroidal anti-inflammatory therapy, joint supplements, and cannabis oil.

Results: After two months of physiotherapy, the dog responded well and was able to walk independently. The efficacy of the hydrotherapy protocol was proven to significantly enhance muscle mass through consistent monitoring of thigh circumference measurements.

Conclusions: Physiotherapy resulted in good clinical results in restoring muscle strength and gait improvement, with a favorable prognosis reported after 6 months of follow-up. Physiotherapy should be considered in dogs with severe hip osteoarthritis managed by FHNO when the contralateral pelvic limb is amputated.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: The procedures for handling animals were conducted under the guidelines of Directive 2010/63/EU, Romanian national law 43/2014 and ISO 10993-2 Animal Welfare Requirements.

Sources of funding: This research received no external funding.

Integrated Physical and Rehabilitative Medicine (PRM) for Snake Envenomation in a Dog: A Case Study

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Background: Snakebite is a special type of traumatic injury, remaining the management of acute soft tissue envenomation damage a challenge.

Case presentation: An adult male dog required hospitalization due to adder bite, 25 ½ hours after the traumatic event. Presenting grade 3 out of 4 envenoming signs, the dog exhibited increased plasma immigration into the soft tissue in the left hind limb, scrotum and trunk, causing lymphadenopathy and blood flow impairment with bleeding diathesis and risk of tissue necrosis of digits and testicles.

PRM was included in the intensive care management of this patient. The purpose was to reduce the tissular inflammation, activate the lymphatic vessels, increase the blood flow and drain out the enzymatic venom components into the vessels so they could be neutralized by the administered antivenom.

Being massage and much mobilization a contraindication, photobiomodulative interventions in a mode-locked pulsing, „point to point"- technique were chosen and performed twice within 24 hours, starting 30 minutes after the antivenom intravenous administration. The hematocele and presumed epididymitis was additionally treated once with capacitive resistive monopolar radiofrequency (5 hours after the second photobiomodulation intervention). Kinesiology taping was thereafter applied to the right carpus, both tarsal joints and scrotum. The dog was discharged one hour later. The kinesiotape treatment lasted two days.

The soft tissue symptoms and hematocele improved markedly, requiring no further interventions.

Discussion: Preliminary studies exist regarding the photobiomodulative effect in snake envenomation. Photobiomodulation, radiofrequency and kinesiotaping are PRM interventions worthy to be further investigated in cytotoxic snake envenoming treatment.

Keywords: snake bite envenomation, dog, physical and rehabilitative medicine, PRM, antivenom, soft tissue damage, function impairment, photobiomodulation, radiofrequency, kinesiology taping

Conflict of interests: "The authors declare no conflict of interest."

Ethical committee: Not applicable as this is a case report of a patient.

Sources of funding: This research received no external funding.

EQUINE PROGRAM:

KEYNOTE AND INVITED LECTURES

Hot topics in dressage:orthopaedics

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Dressage is an Olympic discipline based in the collaboration between a rider and a horse during the performance of a series of exercises of different skills. The aim is to perform these exercises without resistance, signs of pain, discomfort, or lameness. However, welfare has been questioned due to adverse ethograms(1,2) and other signs of discomfort during international competitions. Research regarding prevalence of injuries, timing, clinical signs, risk factors and correlation with management is of major importance to improve welfare, horse comfort during competition, reduce time off, early retirements, and thus economic losses. Despite the increase in interest in this discipline there are only a few publications concerning this information.

In dressage, biomechanics are different from other disciplines(3), requiring spinal flexion during collection in most of the exercises. Moreover, asymmetric weightbearing is common and may increase forces and pressures over certain anatomical structures. Furthermore, repetitions of exercises are necessary to improve performance, making chronic and insidious injuries common.

We hypothesized, that a high number of cases would be multifocal and multi-limb as it is reported in high level human athletes(4). Grand Prix (GP) level is reached at around 10-12 years of age, and, by these ages, osteoarthritis (OA) is highly prevalent in horses. Furthermore, accumulation of soft tissue injuries and scar tissue at some point of their lives is usual, leading to imaging findings that may be subclinical as it is reported in other disciplines (5–7).

For all this reasons, we considered that an in-depth study of previous records of horses in training or competing in this discipline and a longitudinal follow up of these horses over the years could help to improve welfare and to stablish some preventive measures.

Among the cases that met the criteria, medium age was 8,18 years old ranging from 3-21 years, with a peak at 5 years old. Horses below 7, and thus competing or training at youngster's level represented and significant percentage (36,77%) of the total population**.**

Interestingly grade one lameness was only detected in routine examinations despite no previous problems having been perceived by owners or trainers. Thus, unless routine veterinary examinations were performed this degree of lameness would be missed and thus early lesion detection overlooked. Multifocal pain was detected in 209 horses (50,24%) and multilimb lameness in 215 horses (51,48%). This can lead to complicated and long orthopaedic evaluations if an effective treatment of all the issues is attempted.

The most common causes or poor performance were difficulties during collected exercises, which requires spinal flexion and latero-flexion and rotation, as well as issues during canter exercises (i.e. asymmetrical flying changes, bunny hop, defenses...)

Osteoarthritis (OA) was detected in 233 (56,01%), soft tissue in 238 horses (57,21%), and osseous lesions in less horses (11,3%). Combination of affected tissues was presented in 134 (32,21%). Juvenile OA was present in 63 horses (15,14%) of the total population and there was a significant negative correlation with the level reached.

Regarding the main cause of foot region pain, OA of the interphalangeal joints was the most common diagnosis (30,28%). Metacarpophalangeal joint OA was present in horses 23,55%, with medial metacarpal subchondral damage being the most common finding. Suspensory desmitis

was detected in 40,86% of the total population which was higher than the prevalence of foot pain contrary to previous reports(8,9)

In our population, spinal lesions were detected in 75 horses (18,03%). Of interest was that the incidence of location as thoracic and lumbo-sacroiliac injuries was more commonly diagnosed than cervical injuries.

No significant results were obtained when comparing lameness grade in amateurs versus professionals. We suspected that professionals may detect better issues but the fact that higher level horses may be subjected to higher pressures and less time to recover injuries may affect this result.

Horses with no access to turn out in paddocks had increased probabilities of being retired, which evidences the relevance of the protective effect of constant movement in the prevention of orthopaedic disease as previously reported(8).

In conclusion, welfare could be improved by allowing paddock exercise, preventive veterinary examinations and in-depth control of the common areas of lesions in these athletes. The incidence of lesions is different from other disciplines and multilimb and multisource lameness affect half of the population. This point is important when treating and rehabilitating these athletes. Juvenile orthopaedic disease limits the level reached so early veterinary examinations are recommended.

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Regenerative therapies: state of the art and critical update

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Regenerative therapies and orthobiologics are set to transform medicine, offering more natural, effective, and less invasive options for treating injuries, extending performance careers, and improving quality of life.

Orthobiologics play a critical role in human and veterinary medicine due to their potential to enhance natural healing processes, reduce the need for surgery, and improve recovery times. In equine medicine, they are particularly important for treating high-performance horses that suffer from tendon and joint injuries. The American Academy of Orthopedic Surgeons (AAOS) defines orthobiologics as: biological substances found naturally in the body that help injuries help more quickly. This rather broad definition may need to be further specified with regards to its therapeutic elements. Orthobiologics may contain cells, proteins (in solution or encapsulated, ie, mRNA), cytokines or growth factors. These orthobiologic products can be obtained through autologous blood or tissue harvest or can be allogeneic in nature.While an obvious attraction of orthobiologic approaches is the point of care preparation and subsequent application, they can, however, also be used in the setting of an operating room and/or be available as“off-the-shelf” preparations. The regulatory environment for orthobiologics varies by region and species. In human medicine, regulatory bodies like the FDA in the United States have stringent requirements for the approval of new orthobiologic treatments. In veterinary medicine, the regulatory process can be different and often less rigorous, but it is evolving to ensure the safety and efficacy of these treatments. *Platelet Rich Plasma or PRP* is the more popular orthobiologic and is a concentration of platelets derived from the animal’s own blood, rich in growth factors that promote healing. It is widely used in the treatment of tendon and ligament injuries, osteoarthritis, and even surgical wounds. Advances in PRP therapy include optimizing the preparation process to ensure consistent quality and potency, as well as combining PRP with other therapies like stem cells, ESWT and lasertherapy to enhance outcomes. ***Bone Marrow Aspirate Concentrate (BMAC)*** is gaining popularity as a treatment for osteoarthritis and bone healing in veterinary patients. It contains a mix of stem cells, growth factors, and cytokines that promote tissue repair. Innovations in the concentration and application of BMAC are improving its efficacy, making it a valuable tool in mainly treating joint diseases. *Alpha-2-Macroglobulin (α2M)* is an emerging therapy in equine medicine, primarily used to treat joint conditions like osteoarthritis. It works by inhibiting enzymes that break down cartilage, reducing inflammation, and protecting joint health. Derived from the horse's own blood, α2M is injected into affected joints, offering a safe and potentially effective option to slow joint degeneration and improve mobility, especially in performance horses. Ongoing research aims to optimize its use and understand its long-term benefits. *ProStride* is an advanced, autologous therapy used in equine medicine to treat joint pain and inflammation, particularly in cases of osteoarthritis. It combines concentrated platelet-rich plasma (PRP) and autologous protein solution (APS) into a single injection, providing anti-inflammatory effects and promoting cartilage repair. ProStride is valued for its ability to offer rapid pain relief with potentially longer-lasting effects compared to traditional treatments, and it is increasingly used to improve joint health and extend the performance life of horses. *Exosomes* are emerging as a promising tool in veterinary orthopedics, particularly for treating joint and tendon injuries. These small vesicles, derived from stem cells, carry growth factors and proteins that promote tissue repair and reduce inflammation. Recent studies suggest that exosome therapy could enhance healing and improve outcomes in orthopedic conditions, offering a less invasive alternative to traditional regenerative treatments like stem cell injections. Research is ongoing to optimize their use and understand their full therapeutic potential in animals.

Stem cell therapy: Mesenchymal Stem Cells (MSCs) are the most widely used stem cells in veterinary medicine due to their ability to repair tissues and to modulate the immune response. They are commonly derived from adipose tissue, bone marrow, umbilical cord tissue or peripheral blood. Applications include the treatment of osteoarthritis, tendon and ligament injuries, and spinal cord injuries in animals such as dogs, cats, and horses. Recent developments focus on optimizing MSC delivery methods, improving their survival and integration into host tissues, and harnessing their secreted exosomes for therapeutic purposes. Both autologous (from the same animal) and allogeneic (from a donor animal) stem cells are used. Autologous cells reduce the risk of immune rejection, while allogeneic cells offer the advantage of being immediately available, which is crucial in acute injuries. **Besides MSC's, induced Pluripotent Stem Cells (iPSCs)** continue to be a cornerstone of regenerative medicine. These cells, derived from adult tissues, can differentiate into any cell type, making them a valuable tool for treating a variety of diseases in humans, from neurodegenerative disorders like Parkinson's to cardiovascular diseases. Advances in iPSC technology have improved their safety, reducing the risk of tumor formation, and have enhanced methods for directing their differentiation into specific cell types.

Emerging Tissue Engineering technologies: Biomaterials and scaffolds are increasingly used in equine veterinary medicine to enhance tissue repair, particularly in treating musculoskeletal injuries like tendon, ligament, and cartilage damage. These materials serve as a framework for cell attachment and tissue regeneration, mimicking the natural extracellular matrix. Common scaffolds include collagen, hyaluronic acid, and synthetic polymers, which are often combined with stem cells or growth factors to promote healing. Advanced 3D printing techniques are being explored to create custom scaffolds that match the precise anatomy of equine injuries, enhancing the effectiveness of tissue regeneration. Current research is aimed at improving scaffold biocompatibility, degradation rates, and the incorporation of bioactive molecules to optimize healing.

In *genome engineering*, stem cells have been developed (viral and non-viral methods) with capabilities for biologic drug delivery with tunable, inducible, or self-regulating biological responses. In equine orthopedic medicine, these are cutting-edge approaches aimed at treating joint and tendon injuries by to enhance tissue repair and reduce inflammation. Though still in early stages, these technologies hold promise for offering long-term, targeted treatments for common orthopedic conditions in horses, potentially revolutionizing the management of these issues. **Gene editing t**echniques like CRISPR could eventually be used to correct genetic predispositions to conditions like osteoarthritis, potentially preventing the onset of disease rather than just treating symptoms.

Future research is likely to focus on optimizing the delivery and effectiveness of orthobiologic treatments. Innovations such as combining different types of orthobiologics, developing new biomaterials for cell delivery, and advancing genetic engineering techniques are expected to play a significant role in the next wave of orthobiologic therapies.

In conclusion, regenerative veterinary medicine and orthobiologics represent a dynamic and growing area of animal and human healthcare. The field is rapidly advancing, with ongoing research leading to more effective and sophisticated treatments for a range of conditions, particularly those affecting the musculoskeletal system. While challenges remain, including regulatory and ethical considerations, the potential benefits for animal health are significant, paving the way for broader adoption and new innovations in the coming years.

Ultrasonographic diagnosis of muscle injuries in horses

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Introduction

Exercise myopathies are well described in the literature, but less attention has been paid to local muscle injuries such as athletic tears or injuries resulting from trauma. Moreover, they are rarely considered in the differential diagnosis of the cause of lameness in horses. Fibrotic myopathy of the semitendinosus muscle has been largely discussed in the literature especially regarding its surgical management and outcome. The clinical, imaging and outcome aspects of gastrocnemius muscle rupture in foals and adult horses has been reported in several papers. Injuries of several other muscles of the pelvis and pelvic limb have been described including the gluteus medius and semimembranosus muscles, the gracilis muscle and the quadriceps femoris muscle. Muscle injuries involving the neck and thoracic limb have been less documented although cited in the deltoideus, brachiocephalicus and extensor carpi radialis muscles. Diagnosis and documentation of local structural muscles injuries in horses have been made by thermography and nuclear scintigraphy but ultrasonography has been recognized as the best technique to provide information on the lesion structural changes and outcome. Therefore, this paper is focused on the ultrasound diagnosis of muscles injuries in horses.

Technical aspects

A high frequency probe (7.5MHz or more) is adequate for superficial muscles. A low frequency (6 to 2.5 MHz) convex linear is required for examination of deep or strong muscles, especially when covered by a thick skin such as at the lateral aspect of the thigh or dorsal aspect of the back. As echogenicity is highly dependent on the muscle architecture, examination of symmetric muscles using the same technique (pressure on the probe, orientation of the ultrasound beam) is essential to improve sensitivity and specificity of the technique and improve the reliability of the findings.

Findings and lesions

Only lesions involving the muscle bodies are considered in this paper. Tendinopathies and enthesopathies are not. Muscle injuries induce changes in muscle volume, echogenicity and architecture.

Lesions inducing a decrease in size

Fibrotic myopathy is the most documented muscle condition in horses. The semitendinosus muscle is the most affected but the semimembranosus, adductor and gracilis muscles can be involved. This condition has been found in the digital flexor muscle bodies of the forearm secondary to rupture.

Complete rupture of the muscle body is usually followed by a fibrotic muscle atrophy. Muscle atrophy is severe when associated to nerve injuries or fractures. A marked increase of muscle echogenicity correlated to atrophy of the striated muscles fibres is found in neurogenic muscle atrophy. Atrophy of the infraspinosus muscle following suprascapular nerve paralysis is the most common example in horses.

Lesions inducing an increase in size

Muscle body retraction is observed following complete tendon rupture or avulsion at the enthesis. The shortening of the muscle body is accompanied by an enlargement of it. The latissimus dorsi muscle has been involved by such a lesion inducing a typical enlargment caudal to the caudal angle of the scapula.

Muscle body rupture following stressful muscle contraction has been found in the brachiocephalicus muscle, the caudal femoral muscles, the caudal antebrachial muscles and in the caudal crural muscles. In muscles presenting numerous intramuscular aponevroses, rupture of these fibrous components increases the homogeneity of the muscle body.

Traumatic injuries as a result of kicks, trauma over fences or falls are common in horses. In acute situation, bleeding induces heterogenous zones of increased echogenicity followed by anechogenic fluid content. Images made parallel to the fibre axis demonstrate the rupture of the muscle fibers and connective tissue content. Ultrasound follow up shows a progressive recovery of echogenicity and muscle architecture, but the resolution of the lameness is usually quicker.

Muscle lesions without change of size

A specific fascicular hyperechogenic myopathy can be found in race and sport horses and has similarities with the delayed onset of muscle soreness syndrome described in human literature. The involved fascicules show capture (uptake) on nuclear scintigraphic images. The most frequently involved muscles are those responsible for the propulsion (glutei, caudal femoral, latissimus dorsi muscles). Clinical manifestations and imaging resolution is usually seen in few weeks.

Gait deficits associated to the equine cervicothoracobrachial syndrome

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Introduction

The purpose of this presentation is to draw attention on the clinical manifestations and the diagnosis of bone and joints injuries interfering with the brachial plexus nerve roots or the plexus itself and responsible for thoracic limb dyskinesia. The equine cervicothoracobrachial syndrome (CTBS) can be induced by several joint conditions involving the intervertebral joint spaces between C5 and T2 or by lesions involving the first costovertebral joint or by ribs abnormalities. The common link to these conditions is the close anatomical relationships with the brachial plexus and its roots. This syndrome overlaps what is described in human medicine as the cervicobrachial syndrome and the thoracic outlet syndrome although horses lack a clavicle.

Clinical manifestations and lesions

Horses with brachial plexus nerve root impingement caused by caudal cervical vertebral column arthropathies may demonstrate moderate to severe reduction of the cranial phase of the stride due to paresis of the muscles achieving the protraction. In most of these secondary neurological cases (with primary cervical arthropathies) there is little alteration of head movements and fetlock suspension but a clear and sometimes intermittent reduction of the cranial phase of the stride especially at slow gaits. This type of dyskinesia of the forelimbs is accentuated when the affected limb is outside the circle and is usually less visible at faster gaits.

Developmental or acquired arthropathies of the caudal cervical articular process joints (C5-T1) or intervertebral disc lesions responsible for brachial plexus nerve roots pathological and functional alterations are part of the equine intervertebral CTBS. Other lesions causing the same typical dyskinesia of protraction of the forelimb in horses include arthropathy of the first costovertebral joint and congenital abnormalities of the first rib such as agenesia, hypoplasia, and synostosis with often incomplete and dystrophic fibrous union of the first 2 ribs.

Pathophysiology of the clinical manifestations

All these abnormalities or injuries are in close anatomical relation with the brachial plexus components, either with its nerve roots (ventral rami of C6 to T1 cervical spinal nerves at the level of the intervertebral foramina) or the brachial plexus itself, passing between the scalenus medius and the scalenus ventralis muscles and then crossing over and lying on the first rib. Resulting alteration of the nerve conduction is responsible for paresis of the muscles achieving the protraction and stability of the forelimb. They include the supraspinatus muscle innervated by the suprascapular nerve (coming from the cervical nerves C6 and C7), the cleidobrachialis muscle innervated by the axillary nerve (coming from C7 and C8), and the biceps brachii and brachialis muscles innervated by the musculocutaneus nerve (coming from C6, C7 and C8). Involvement of the radial nerve roots (C7, C8 and T1) or pathway may induce forelimb paresis (muscle weakness) predisposing the horse to faulty steps, stumbling or even falling.

The clearest manifestation of horses affected by a CTBS is alteration of the cranial part of the swing phase. For other conditions, a swing phase lameness is rarely seen alone. With shoulder joint or bicipital apparatus injuries the stance phase lameness induced by the pain when load is

put on the affected limb is often clearer. For horses presenting a CTBS, there is often an elongated caudal part of the stride compensating the shortened cranial phase.

Conclusions

The manifestations of CTBS are sometimes intermittent. Their identification requires a careful clinical examination, especially at slow gaits. As consequences of forelimb dyskinesia may be dangerous for the rider and the horse, special attention should be given to the forelimb protraction and carpus stability which may be affected unilaterally or bilaterally.

Biomechanical bases of equine rehabilitation

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Lameness or gait alterations are created by pain or functional impairment affecting the anatomical structures of the locomotor system. Clinical manifestations of musculoskeletal injuries are the live expression of functional anatomy and are therefore directly related to the timing and situations producing the higher biomechanical stresses on bone or soft tissue structures. The aim of this lecture is to demonstrate how a careful clinical examination of lame horses provides specific information on the origin of pain and why this information is essential for the management of lame horses. Indeed, complete clinical examination enables the identification of the less comfortable situations for the horse. Immediate conclusions can then be drawn to establish the most adequate exercise level and program which is an essential aspect of the management of lameness. The purpose of this presentation is to highlight the main features of the clinical presentation of some common conditions and to show how a rational management of affected horses can be built on these observations.

Podotrochlear syndrome (PTS-navicular disease) is common in sport horses. Reduction of the caudal phase of the stride at the walk when the lamer limb is on the inside of a short circle is the most typical manifestation of this syndrome. The biomechanical explanation is the longer stance phase duration at the walk that increases duration of the distal interphalangeal joint (DIPJ) extension combined with associated movements of collateromotion and rotation on the circle. The lameness characteristics are less specific at the trot and are significantly improved on a straight line and on a soft surface. Many horses suffering from this condition are improved with adequate exercise and shoeing management without the need for injections or other medical or surgical procedures. Understanding of the etiopathogenesis of pain explains why adequate trimming and corrective shoeing the most effective ways for immediate and long-term management of this condition are. The aim of the kinesitherapic shoe is to facilitate dorsal (under the toe) and, above all, dorsocollateral (under the dorsal part of the quarters) rolling. Support under the heels (onion or bar shoe, but no elevation of the heels) complements the biomechanical efficiency of the shoe. This also explains why horses are usually improved on soft surfaces as the penetration of the toe (and quarters on a turn) reduces DIPJ extension and collateromotion. Therefore, exercise on hard circles must be avoided whereas working on soft surfaces mainly on straight line and large turns is recommended.

A worsening of the lameness at the trot on the opposite circle to the affected limb can be seen in horses presenting **subchondral bone trauma of the medial part of the metacarpal condyle**. When the limb is on the outside of a circle on hard ground, pressure under the foot is shifted abaxially and concentrated close to the medial quarter. The resulting increase in pressure at the medial aspect of the limb explains the worsening of the lameness. Efficient management of the stresses and their consequences can be achieved by a shoe reducing the ground reaction force at the medial aspect of the foot and by exercising the horse on soft surfaces. Similar manifestations can be seen in racehorses with radial carpal bone disease and lesions of the radial fossa of the third carpal bone.

Cranial enthesopathy of the cranial meniscotibial ligament of the medial meniscus (CrMTL-MM) is one of the most common stifle conditions in equine athletes. When this condition is symptomatic, the lameness can be worse on the corresponding circle (affected limb inside the circle) or on both circles. Pain when the limb is inside the circle is induced by the lateral rotation

of the tibia during the second part of the stance phase increasing tension on the CrMTL-MM. Some horses are also lame on the opposite circle (affected limb on the outside of the circle) because of the concentration of the load on the medial FTJ. Management is based on clinical manifestations and includes avoiding exercises that increase flexion of the FTJ such as high jumps or aquatic exercises (aquatreadmill or swimming).

Conclusions

Looking at the type of clinical manifestations (not only the grade of lameness) provides the clues to assess the significance of imaging findings and to implement adequate management of lame horses. This is an essential support to establish short-term rehabilitation programs and long-term recommendations to prevent reinjury. Injecting joints, tendons or ligaments helps manage the consequences of biomechanical stresses but does not treat the cause of these lesions. Reducing and manipulating the biomechanical stresses is essential and often sufficient to manage many injuries. Scrutinizing the details of the clinical presentation to understand how the horse has adapted his gait pattern is the most interesting aspect of the diagnosis of lameness and the most useful and less invasive approach to help affected horses.

Update of Rehabilitation Techniques

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There has been a recent increase in the scientific literature addressing rehabilitation techniques and their efficacy in treating spinous process impingement, multifidus muscle dysfunction, and thoracolumbar pain in horses. A key focus is on physiotherapeutic modalities, including extracorporeal shockwave therapy, interspinous ligament desmotomy, and the effects of whole-body vibration, balance pad exercises, and axial tail traction.

Spinous Process Impingement: In a cohort receiving extracorporeal shockwave therapy, results showed an 83% increase in mechanical nociceptive thresholds (MNTs) after three sessions, with regional variation in response.

Multifidus Cross-Sectional Area (CSA): Hind limb lameness was treated through rehabilitation exercises over 12 weeks, resulting in significant increases in thoracolumbar multifidus CSA and a decrease in postural sway, suggesting a moderate to strong correlation between multifidus CSA and postural stability. Additionally, balance pad exercises targeting postural sway led to a significant decrease in center of mass displacement, with multifidus CSA increasing only at T14.

Whole-Body Vibration Therapy: Horses with thoracolumbar pain demonstrated reduced mediolateral accelerations and increased multifidus CSA following 30 days of vibration therapy, indicating improved postural stability and reduced pain. MNTs showed a significant reduction in pain by day 30.

Axial Tail Traction: Tail pull exercises in horses with back pain resulted in increased MNTs, reflecting decreased pain in the thoracic (83%), lumbar (50%), and pelvic (52%) regions. This suggests axial tail traction is effective in reducing pain associated with spinous process impingement.

Core Stability: Core stability exercises, including weight shifting, baited stretches, and elastic resistance band work, have been shown to increase multifidus muscle activation and improve spinal kinematics. Research evaluating the effects of baited stretches demonstrated increased multifidi CSA with various stretching regimens, contributing to enhanced core stability. Elastic resistance bands further reduced thoracolumbar lateral bending and wither axial rotation, though no significant effects were noted on lumbosacral flexion.

Electromagnetic Therapy: Bio-electromagnetic energy regulation therapy (BEMER) applied to horses with thoracolumbar pain resulted in significant improvements in MNTs, spinal flexibility, and postural stability, though no significant changes were observed in muscle tone or ground reaction forces.

These findings suggest that targeted rehabilitation techniques, including mechanical and manual therapies, can effectively improve spinal function, reduce pain, and enhance core stability in affected horses. However, the variability in response and the need for longer treatment durations warrant further investigation.

Equine Myofascial Therapy

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Fascia is a complex connective tissue that supports and connects various structures in the body, including the dermis, superficial and deep fascia, tendons, ligaments, and joint capsules. It is essential for maintaining structural integrity, facilitating fluid transport, and contributing to biomechanical functions like force transmission and mobility. Recent studies have explored the layered organization of fascia, its role in fluid dynamics, and its biomechanical properties, which affect tissue stiffness and pressure regulation. Additionally, fascia has been shown to play a role in mechanoreception, linking it to posture, joint position sense, and even emotional sensations such as fear and pain.

Fascial dysfunctions, including densification, adhesions, and fibrosis, arise from chronic strain, repetitive use, trauma, or surgical interventions. These conditions often present as hypersensitivity, altered tissue mobility, and compensatory movement patterns. Densification involves viscoelastic changes without histological alteration, while adhesions and fibrosis involve significant histological changes, particularly within the dense connective tissue. These dysfunctions affect both local tissue integrity and broader biomechanical function, often manifesting as pain, restricted mobility, and altered posture.

Evaluation of fascial health involves assessing tissue texture, density, tone, and mobility, as well as sensory responses to touch, pressure, and friction. Variations in tissue tension and the presence of trigger points or fibrotic areas are critical for understanding the degree of dysfunction. Therapeutic approaches focus on restoring balanced tone and movement across fascial lines and compartments. Localized treatment aims to address areas of tension or adhesion, while regional approaches target compensatory mechanisms and asymmetries in tension between opposing myofascial lines. Global dysfunctions, involving distant compensations, require a more comprehensive approach to ease restrictions and normalize tension across the fascial network.

Myofascial treatment techniques include manual therapies such as myofascial release, trigger point therapy, and acupuncture. Instrument-assisted methods, such as Graston techniques and cupping, have been shown to reduce pain and improve function in both human and veterinary applications. For example, cupping has demonstrated efficacy in reducing back pain in thoroughbred racehorses, although no changes in mechanical nociceptive thresholds were observed.

Fascial treatment modalities also extend to movement therapies, including yoga, Pilates, and core stabilization exercises. These approaches focus on promoting proper spinal flexion, balance, and overall mobility. Techniques such as elastic therapeutic taping and resistance band exercises have been shown to improve fascial function by enhancing tissue flexibility and reducing compensatory movement patterns.

In conclusion, fascia is a critical component of the body’s structural and functional systems. Its involvement in both mechanical and sensory processes, as well as its susceptibility to dysfunction, underscores the importance of comprehensive diagnostic and therapeutic approaches aimed at restoring fascial health and function.

Diagnosis and Management of Exertional Rhabdomyolysis

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Classification of Exertional Myopathies

Horses with exertional myopathies often fall into one of two main categories; 1) horses in which an intrinsic muscle defect does not appear to be present, but a temporary imbalance within the muscle cells causes a *sporadic exertional myopathy* and 2) horses in which the primary underlying susceptibility appears to be the result of an intrinsic defect in the muscle resulting in a *chronic exertional myopathy.* Chronic exertional myopathies can be subdivided into those that are associated with an increase in creatine kinase (CK) and aspartate transaminase (AST)- exertional rhabdomyolysis (ER) and those that cause exercise intolerance without any elevations in muscle enzymes (see proceedings on Myofibrillar Myopathy).

To evaluate the possibility that horses have subclinical ER an exercise test can be performed to assess CK activity before exercise and 4-6 hrs after a 15 min exercise test at a walk and trot. Subclinical ER is indicated if CK is double (or more) the resting normal values.

Unique aspects of intramuscular calcium regulation

Horses are particularly susceptible to exertional rhabdomyolysis because of unique adaptations that have evolved in the way they manage intracellular calcium during muscle contractions. Horses have large amounts of a high affinity binding protein calsequestrin in storage sites (sarcoplasmic reticulum) which allows more calcium to be stored and released down a concentration gradient with each contraction. Within a physiological range, this enhances the force of muscle contraction. Horses also have a unique truncation of a gene called sarcolipin involved in regulating the pump which returns calcium to their storage sites leaving this pump functioning maximally These adaptations in calcium regulation appear to have placed horses on a fine edge with enhanced performance on one side and rhabdomyolysis on the other. Excessive levels of calcium accumulating in the muscle cytoplasm is often the final common pathway for muscle cell damage for most exertional causes of rhabdomyolysis.

Dantrolene

It is important to understand this mechanism for developing rhabdomyolysis because there are drugs such as dantrolene that slow calcium release from the SR and can be used to treat or prevent rhabdomyolysis. Dantrolene can be given orally at doses of 2-4 mg/kg 60-90 min before exercise when horses are being brought back into exercise after an episode of rhabdomyolysis for a period of 2-3 weeks or if there are specific events likely to precipitate an episode. Veterinarians prescribing dantrolene should be aware of the drug testing requirements and withdrawal times for competitions.

Causes of chronic exertional rhabdomyolysis

1. **Sporadic ER**
    - Environments impact muscle function

2. **Chronic ER**
    - **Malignant hyperthermia**
        - Defect in the calcium release channel in Quarter Horse-related breeds

- **Recurrent Exertional Rhabdomyolysis**
  - Abnormality in intramuscular calcium regulation contraction and relaxation.
  - Fit, nervous horses performing in a high stress environment.
  - Diagnosis based on history, clinical signs, high serum CK and AST.
  - Managed with diet- lower nonstructural carbohydrate (NSC) and added fat, reducing stress/excitement, 2 mg/kg of oral dantrolene 60-90 min before exercise.
  - Daily exercise- resumed with CK of ≈3000 U/L.
- **Type 1 polysaccharide storage myopathy (PSSM1)**
  - Autosomal dominant gain-of-function mutation in *GYS1* causing >1.5-fold higher glycogen concentrations
  - Common in unfit horses, Quarter Horse-related, draft, Warmblood breeds.
  - Diagnosed by genetic testing
  - Managed with regular exercise, hay < 11% NSC, concentrates < 15% NSC, and vegetable oils (120-240ml per day)
- **Type 2 PSSM-ER**
  - Abnormal glycogen metabolism causing excessive glycogen storage and high CK
  - Researched in Quarter Horses likely present in other breeds
  - Diagnosed by muscle biopsy- dark glycogen stain and small amounts of abnormal polysaccharide
  - Managed similar to PSSM1
- **Myofibrillar Myopathy in Arabian Horses**
  - Arabian endurance horses with a history of high CK activity after endurance rides (> 10,000 U/L) or during exercise that follows a week or more of rest.
  - Do not necessarily show the same degree of pain as acute ER.
  - Myoglobinuria with mild muscle stiffness.
  - Diagnosed by identifying desmin aggregates in muscle biopsy
  - Oxidative stress from a lack of adequate cysteine-based antioxidants likely cause.
  - Treated with increased antioxidants such as N-acetyl cysteine and coenzyme Q10.

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Information om muscle diseases can be found under the resources tab (scroll down) at ValbergNMDL.com

Diagnosis and Management of Other Exertional Myopathies

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The seminal finding of amylase-resistant polysaccharide in skeletal muscle of horses with exertional rhabdomyolysis (ER) led to the discovery of equine polysaccharide storage myopathy (PSSM). With muscle glycogen concentrations twice normal and insulin sensitivity high, PSSM horses were manage with a low nonstructural carbohydrate (NSC) diet and provision of fat for supplemental energy. Fifteen years later, a dominant gain of function mutation in the glycogen synthase 1 gene (*GYS1*) was discovered in a subset of PSSM horses resulting in the division of PSSM into Type 1 (PSSM1) which refers to horses with the *GYS1* mutation and Type 2 (PSSM2) which refers to horses that have abnormal appearing amylase-sensitive or resistant polysaccharide in muscle biopsies that do not possess the *GYS1* mutation. During the past decade, research has focused on determining the cause or causes of PSSM2 and the best means to manage this condition. To account for the possibility that there were potentially different causes for PSSM2, a disease defined by the histological presence of abnormal appearing polysaccharide, research focused on evaluation of PSSM2 in specific breeds.

TYPE 2 PSSM IN QUARTER HORSE-RELATED BREEDS

As described in the previous proceeding, research found that in Quarter Horse-related breeds, PSSM2 presented as exertional rhabdomyolysis (ER) characterized by high muscle glycogen concentrations, and high serum creatine kinase (CK) and aspartate transaminase (AST) activities. [5] PSSM2-ER responded well to low NSC, high fat diets combined with regular exercise. Although there appeared to be a familial relationship amongst many PSSM2 Quarter Horses, evaluation of whole genome sequences of genes known to cause glycogen storage disorders in other species failed to identify the molecular basis for the disease. Thus, the basis for this glycogen storage disease in Quarter Horses has yet to be determined.

MYOFIBRILLAR MYOPATHY IN ARABIAN HORSES

An initial study of Arabian horses with and without prior ER included a 47 min submaximal standardized exercise test. Metabolic exercise responses were normal. Horses with ER had more internalised nuclei in mature myofibers and more aggregates of cytoplasmic glycogen in gluteal muscle leading to a diagnosis of PSSM2. However, unlike Quarter Horses, glycogen concentrations were not higher than in controls. Additional immunohistochemical stains identified large aggregates of the cytoskeletal protein desmin in some ER horses. Desmin is an intermediate filament associated with the Z disc of sarcomeres that interconnects myofibrils and links them to the cell membrane, mitochondria, and the nucleus. Myofibrils are formed by a serial alignment of sarcomeres that contain thick (primarily myosin) and thin filaments (primarily actin, tropomyosin, and troponin) boarded by Z discs. The ultrastructural changes in horses with desmin aggregates included prominent Z-disc degeneration, focal myofibrillar disruption, ectopic protein accumulation, and regional accumulation of β-glycogen particles. [10] Findings from these studies led to the application of the term myofibrillar myopathy (MFM) to describe horses with abnormal desmin aggregates in muscle biopsies that occur in concert with myofibrillar disarray.

The Arabian horses with desmin aggregates had a history of high CK activity after endurance rides (> 10,000 U/L) or during exercise that follows a week or more of rest. This contrasts Arabians with recurrent exertional rhabdomyolysis (RER) that develop ER soon after starting races when excitement is high.

To investigate the pathophysiology of MFM in Arabians, resting and 3 h postexercise transcriptomes of gluteal muscle and the resting skeletal muscle proteome were compared between MFM and control Arabian horses. Three hours after exercise, MFM vs. control muscle had significant alterations in sulphur compound/cysteine metabolism. Proteomic analysis revealed significantly lower antioxidant peroxiredoxin 6 (a cysteine-based antioxidant) and higher fatty acid transport enzyme carnitine palmitoyl transferase. These results led to the proposal that a high capacity to oxidize fatty acids and generate reactive oxygen species during aerobic exercise and inadequate cysteine synthesis during exercise led to and a deficiency of cysteine-containing antioxidants, chronic oxidation and aggregation of key proteins such as desmin and rhabdomyolysis. Desmin is particularly sensitive to oxidation at cysteine 333 which consequently alters the ability of desmin to be degraded by proteases.

Management of MFM in Arabians: Armed with information on the potential pathophysiology of MFM in Arabians, a new management regime was developed for MFM. Recommendations include regular daily exercise and maximal turnout, a staple of managing ER. Although Arabian endurance horses are typically fed higher fat diets, the potential of fat metabolism to generate reactive oxygen species questions whether MFM horses should have extremely high levels of fat intake (>15% total DE intake). Further, endurance riders typically feed low-protein rations because they are concerned that high-protein diets may increase body heat, urine production, and water needs. These crude protein levels may be deficient in amino acids such as lysine, methionine, and threonine needed for muscle repair and generation of cysteine-based antioxidants in MFM horses. MFM recommendations for concentrates include higher levels of protein (12-14% CP) containing high-quality amino acids and moderate levels of NSC (20-30%) and fat (4-8%). As described below for Warmblood horses a specific supplement containing N-acetyl cysteine and additional amino acids has been developed for MFM horses called the MFM pellet (KER.com). Aggregates of desmin can be decreased in cell culture models through the addition of N-acetyl cysteine.

MYOFIBRILLAR MYOPATHY IN WARMBLOOD HORSES

Following the discovery of desmin aggregates in muscle biopsies from PSSM2 Arabians, our lab began to routinely evaluate desmin staining in diagnostic submissions. We found that many Warmblood horses previously diagnosed with PSSM2 also had desmin aggregates in type 2A and a few type 2X muscle fibers. A review of these cases showed that clinical signs of MFM in Warmbloods were not associated with ER but rather exercise intolerance, reluctance to go forward, stiffness and poorly localised lameness after limited exercise. Serum CK activity was historically normal. Further, muscle glycogen concentrations did not differ between MFM cases and controls.

Abnormal mitochondrial morphology, focal Z disc degeneration, myofibrillar disruption and accumulation of ectopic material arising from the Z disc was evident in ultrastructural evaluation of MFM cases. The resting transcriptomes and proteomes of gluteal muscle was compared between MFM Warmbloods and control horses. Mitochondrial complex I had several differentially expressed proteins. Complex I is the first step in cellular respiration and generates the most reactive oxygen species. *CHAC1* was the highest differentially expressed gene. The protein product of CHAC1 degrades the cysteine-based antioxidant glutathione. Thus, lack of cysteine-based antioxidants and oxidative stress could also play a role in Warmblood MFM.

Although the Z-disc has traditionally been viewed as a passive constituent of the sarcomere, it is now known to be one of the most complex macromolecular structures in biology containing hundreds of different proteins. During muscle contractions the stretch in the Z disc is transmitted via desmin to the cell membrane where integrins form a connection with the extracellular matrix. Z discs are believed to sense muscle stretch and integrate multiple signal transduction pathways in which Z disc proteins shuttle to the nucleus, implement transcription of genes and generate an appropriate training response. The top significantly differentially expressed proteins in MFM horses included these shuttle proteins. Thus, the underlying basis for MFM in Warmbloods was proposed to involve oxidative stress from altered cysteine-based antioxidant response, Z disc instability, and aberrant mechanosignaling and mechanotransduction responses to training. Evaluation of the coding sequence of genes known to cause MFM in humans failed to identify a genetic mutation responsible for MFM in Warmbloods.

MANAGEMENT OF MFM

Based on the afore mentioned studies new management regimes were developed for MFM horses. To allow horse's muscles to recover from exercise, a regime of 2 days off followed by 3 days of work is recommended. Good-quality grass or grass-legume mixed hays (55-65% NDF, 10-12% CP, 10-17% NSC) are preferable[15]. There is no evidence that extremely low-NSC diets are needed by Warmbloods with MFM unless they suffer from insulin dysregulation or obesity. In addition, there does not appear to be a scientific reason why additional fat, a potential source of oxidative stress, would be of benefit to Warmbloods with MFM. Therefore, recommended concentrates for MFM horses have higher levels of protein (12-14% CP) containing high-quality amino acids and moderate levels of NSC (20-30%) and fat (4-8%). To enhance cysteine-based antioxidants, a supplement containing N-acetyl cysteine and specific amino acids has been developed for MFM horses (MFM Pellet, KER.com). Additional antioxidants such as Coenzyme Q10 (CoQ10), a key component of the first step in the mitochondrial electron transport chain are also recommended. Feeding CoQ10 and N-acetyl cysteine to active Thoroughbred horses had been shown to increase post-exercise muscle glutathione concentrations. An unpublished survey of owners of MFM horses following this regime found that 92% improved their performance with 65% of MFM horses meeting the owners' expectations (Valberg et al unpublished observation).

GENETIC TESTS

Commercial genetic tests are offered for PSSM2; however, research does not support their use.Utilizing Quarter Horses diagnosed with PSSM2 by muscle biopsy, a recent study found that about 60% of Quarter Horses possess one or more of these commercial variants (termed P2, P3 and P4) regardless of whether they were healthy or had histopathologic evidence of PSSM2. In addition, evaluation of commercial genetic tests for MFM (P2, P3, P4) in Arabians and Warmbloods failed to validate the accuracy of these tests in diagnosing MFM. These commercial genetic tests appear to identify genetic variants common in the horse genome and not associated with a muscle disease.

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Feeding horses with poor performance

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Recently, ration formulation in performance horses has attracted much attention to maintain health, improve performance or to manage various health problems related to poor performance. The reasons for poor performance are variable. A careful medical history and the examination of the different organ systems such as the lower and upper respiratory tract, the cardiovascular and musculoskeletal system or the gastrointestinal tract are essential to develop an appropriate diet. In addition, management including type of exercise, training, participation in competitions, transportation and stress factors must also be considered.

For a balanced diet, the following points must be considered

- Ration needs to be tailored to the individual's requirement
- Ration should fall within a horse's capacity for dry matter intake
- Ration should accommodate specific needs (e.g. adequate forage intake)
- Ration should be tolerated well by the equine (e.g. limitation of starch and fat, nutrient tolerances)

The hygienic quality (e.g. control of spoilage) and palatability of the feedstuffs as well as the feed intake behaviour should be monitored to ensure the efficacy of the diet. In many cases, it is more appropriate to control the daily ration and the individual feed intake behaviour rather than relying on blood analyses, which may not truly reflect energy and nutrient intake.

All nutrients, whether essential or nonessential can adversely affect animal health when amounts in the diet become excessive or insufficient. Knowledge of specific individual requirements helps to detect inadequate nutrient intake provided by the actual ration. There are several expert panels which obtain information on energy and nutrient requirements in horses, e.g. like NRC (2007), INRA (1990) or GEH (2014). For ration formulation and adequate assessment of the diet, further information on actual body weight, optimal body weight, body condition and the type of exercise of the horse is essential for diet formulation.

For commercial feeds, analysis of crude nutrients such as protein, fat and fibre as well as minerals and vitamins are available on the respective feed labels. For cereals or grains, using average values provide sufficient information on nutrients in most cases. However, feed composition of forages is challenging as their nutrient content vary depending on several factors such as climatic conditions, soil type, grass species, fertilization management, cutting time, harvesting technique, and other factors.

For large horse stables, routine nutrient analysis of the respective forage is strongly recommended for optimal diet formulation.

A lack of forage in the ration contributes to several health disturbances including gastric ulcers, hindgut acidosis, and behavioural problems. In general, diet should always incorporate a minimum quantity of chewable forage such as grass, hay or haylage. In literature, a daily minimum forage intake (based on dry matter) of 1.5-2 % of body weight (BW) is recommended.

When compared to hay, well preserved haylages have less aeroallergens which is clearly favourably in horses with respiratory diseases.

Cereal carbohydrates comprise an important part of the diet of performance horses with a high daily energy requirement. Several health problems such as insulin dysregulation, gastric ulcers, colic or hindgut acidosis are associated with the intake of high amounts of starch and sugars. To reduce the risk of a significant ileal outflow of starch into the hindgut, it is recommended that highly processed grains and compound feeds should be fed. A maximum meal size of 0.3 kg/100 kg BW (or 1 g starch/kg BW per meal) is recommended for compound feeds or grains with a starch content between 30% and 40%. Even further limitations to meal size are necessary in feedstuffs with starch and sugar levels exceeding 40%.

Protein requirements are increased in performance horses compared to maintenance conditions to ensure optimal muscle metabolism, muscle build up and the repair of tissue damage. However, the precise quantification of extra protein for exercising horses is challenging and individual protein requirements vary among individuals, breed and type of exercise. However, the intake of excessive protein may also have adverse effects on thermoregulation and acid-base balance. Depending on the crude protein intake by forages, protein-rich forages such as alfalfa or sainfoin, or protein balancers should be included in diets for performance horses. However, horses with kidney or liver disease may benefit from a lowered protein intake, but partly replaced by selected amino acids such as branched-chain amino acids.

For performance horses with poor performance, there is interest in increasing the lipid content of the diet usually in the form of vegetable based oils There are numerous potential advantages to fat supplementation of the equine diet including higher energy density, lowered heat production during exercise due to improved efficiency in the utilisation of metabolizable energy, a reduction in breathing effort due to lower carbon dioxide production, higher resting muscle glycogen stores, metabolic adaptation to fat supplementation in muscle that facilitates a glucose sparing effect during exercise. However, fat intake should be limited to a daily maximum <1 g/kg BW as a higher fat intake is associated with an impaired fibre digestibility in the hindgut.

Horses that sweat during exercise lose considerable amounts of water and electrolytes, such as sodium (Na), potassium (K) and chloride (Cl). Significant sweat losses between 7-10 L can occur even during moderate exercise in leisure horses (500-600 kg BW); significantly higher sweat losses can be observed in endurance riding or in Three-day eventing competitions.

Numerous studies have shown that most leisure and sport horses cannot compensate their increased Na and Cl requirements via a salt lick, whereas the K supply can be covered by an adequate forage intake, even under situations with a high K requirement. A lack of sufficient electrolyte intake in performance horses may cause poor performance, especially under hot and humid conditions.

The oral supplementation of electrolytes, especially Na and Cl, is a useful strategy in order to replace electrolytes that are lost by sweating in performance horses.

Although there are numerous electrolyte supplements on the market, commercial products are usually not well formulated, so that salt supplementation (e.g., table salt without fluorine and iodine) is recommended in the nutritional management of horses.

Adding electrolytes into the diet, sufficient water must be always freely available in order (i) to compensate water losses through sweating; (ii) promoting electrolyte absorption in the gastrointestinal tract; and (iii) and counteracting the risks of salt overdosing, as renal elimination is dependent on water supply.

The importance of vitamin E and selenium (Se) especially in muscle metabolism is well described. However, a low Se supply in diets for performance horses in combination with the use of supplements and / or mineral feeds is rare. In contrast, a high Se supply is frequently observed in sport horses. The Vitamin E supply in sport horse rations can vary greatly, with both very low and very high vitamin E intakes being observed. A high Vitamin E supply above the requirements (~400-800 mg Vitamin E/100 kg BW) is often regarded as positive, especially in horses with exertional myopathies.

Although the market offers enormous supplements for horses with poor performance, in most cases scientific evidence is missing. Nutraceuticals may support health and performance, but those supplements cannot compensate feeding errors.

Nutrition in high level sport horses: Speed vs endurance

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The superior athletic ability of horses is closely related to their high maximal aerobic capacity, large intramuscular energy stores (glycogen), high mitochondrial volume in skeletal muscle, the ability to increase oxygen-carrying capacity of blood at the onset of exercise (splenic contraction), efficient thermoregulation and the efficiency of gait.

The primary sources for energy production in the exercising horse are carbohydrates and fats and, to a much lesser degree, amino acids. The extent to which each fuel is utilized depends on several factors, including the intensity and duration of exercise, the availability of fuels, and the influence of hormones. However, most studies in exercising horses have focussed on glycogen stores, whereas only a few studies have addressed muscle triglyceride or protein stores.

At the onset of exercise energy is primarily derived from the anaerobic pathways. At maximal short lasting exercise speeds, energy must be predominately generated by anaerobic pathways. Herby glycogen serves as the major fuel source, resulting in an accumulation of lactate. However, within ~60 sec after the onset of exercise, there is a clear shift to aerobic metabolism even during high-speed exercise.

In horses, resting muscle glycogen stores varied around 550-650 mmol/kg dry matter (DM). Following any type of performance, glycogen stores in muscle and liver tissue decline during exercise. During short-term intensive exercise, muscle glycogen stores may be depleted only by 20-35%. Endurance exercise results in the greatest depletion of muscle glycogen. For example, during endurance rides in the order of 100 km, muscle glycogen can decline between 50 and 100%.

During endurance, the oxidation of fatty acids provides the major source of energy. The fat stores represent herby the largest nutrient reserve whereas the carbohydrate stores such as glycogen are limited.

The different fat depots like skeletal muscle or adipose tissue store triglycerides, with the largest storage capacity in the adipose tissue.

The triglyceride content in the skeletal muscle varied between 7-128 mmol/kg DM with large breed related differences. It is supposed that triglyceride stores are used largely during prolonged exercise, but without depletion of muscle fat even during endurance rides. Fatty acids (hydrolysis of triglycerides in glycerol and fatty acids) are efficiently mobilised from the adipose tissue into the bloodstream during exercise, and those fatty acids may be utilised for ATP production in the muscle rather than intramuscular triglycerides stores.

Interestingly, high pre-exercise muscle levels of triglycerides before exercise seems to favourite the utilisation of muscle triglycerides during exercise. But the higher utilisation of muscle triglyceride stores does not necessarily reflect a better exercise performance. It is reported that those endurance horses with a greater depletion of muscle glycogen stores and a lower reduction of muscle triglycerides were among the best during a 50 km ride compared to those horses that finished the competition at lower speeds.

Beside carbohydrates and fat, exercise induces changes in the amino acid profile in blood and muscle. Increases in branched-chain amino acids (BCAA) such as leucine, isoleucine, and valine are observed during endurance exercise in horses by an increased output by the liver, where proteolysis has been shown to accelerate during exercise. Furthermore, it is supposed that certain amino acids are oxidised for energy production in the muscle, although the contribution of protein to energy expenditure in horses during exercise remains open (approximating to a maximum of 10-16 %).

In contrast to speed exercise, endurance exercise in horses, particularly when performed under hot and humid conditions will result in the depletion of the energy stores like liver and muscle glycogen and in excessive water and electrolyte losses. These changes impair exercise capacity and result in cardiorespiratory and metabolic alterations contributing to fatigue in endurance horses.

The primary aim in feeding the performance horse is long-term adaptation to exercise-related changes in energy and nutrient requirements; however, short-term manipulation regarding the amount and type of feed and time of intake of a meal before, during or after competition may help to improve performance during exercise.

As forages are fundamental for gastrointestinal health, forages should be offered first to horses. A daily minimum hay intake of 1.5-2 % of BW (based on DM) is recommended in horses performing mainly short distances, such as Thoroughbred or Standardbred horses. In those horses, hay restriction should not be longer than 6-8 h before the start of the competition because forage withheld for more than 8-12 h is associated with an increased risk for gastric ulcers and colics.

Daily ad libitum forage intake (2-3% of BW, based on DM) as the main energy source and free access to forages until the start of the competition should be provided in horses performing long-lasting distances, such as endurance horses or three-day eventers.

Attempts to delay fatigue in horses have been made by providing carbohydrates fed as starch (1-3 kg cereals in 500-600 kg BW) or glucose 2-4 h before exercise, but this practice resulted in increased insulin secretion followed by pronounced hypoglycaemia, decreased lipolysis, and increased depletion of muscle glycogen during exercise. In these studies, high glycaemic and insulinemic responses were monitored before the start of exercise; the fall in plasma glucose during exercise was directly proportional to blood glucose and insulin levels at the beginning of exercise. Insulin is known to inhibit lipolysis and fatty acid oxidation in skeletal muscle, resulting in an impaired availability of fatty acids in energy contribution, but increased reliance on carbohydrate stores. For these reasons, it is recommended to feed a starchy meal no later than 3-4 h before the onset of exercise and to limit the meal size to 0.3% of BW using grains or compound feeds that have undergone intensive thermal processing.

After cessation of endurance exercise, the rate of glycogen repletion is much lower than in other animal species and in the human athlete. Following complete glycogen depletion after endurance riding, complete repletion may take up to 92 h. In general, it is concluded that glycogen resynthesis in endurance horses, but not in speed horses is a limiting step in recovery after a strenuous competition exercise.

Several studies have shown that the rate of muscle glycogen repletion is only moderately influenced by diet. For example, low-carbohydrate (hay), moderate-carbohydrate (hay and concentrate) and high-carbohydrate diets (hay, concentrate and glucose infusion [<1 g glucose/kg BW]) had similar effects on glycogen repletion. In addition, oral glucose application (3 g/kg BW in a single dose) had no effect on muscle glycogen repletion after an intensive work bout.

Considering energy requirements in performance horses, a starchy meal can be offered 2-4 h after cessation of exercise (high speed and endurance), but meal size should be limited to a maximum of 0.3% of BW. For endurance horses there is special focus in increasing the lipid content of the diet as fat supplementation improves the efficiency in the utilisation of metabolizable energy during long distances with a glucose sparing effect. However, fat intake should be limited to a daily maximum <1 g/kg BW as a higher fat intake is associated with an impaired fiber digestibility in the hindgut. However, fat-enriched diets (5% fat of dry matter intake) had no beneficial effects on the rate of muscle glycogen repletion after exercise in horses.

Oral administration of an electrolyte solution containing 12 g Na, 24 g Cl, 9 g K and 1 g each of Ca and Mg, increased significantly muscle glycogen repletion after intensive exercise in Standardbred horses. The supplementation of electrolytes to improve glycogen repletion is a promising approach in the dietary management of sport horses, independent of the type of exercise.

Assessment of skeletal muscle oxidative capacity for training monitoring, fitness evaluation and detection of mitochondrial dysfunction in sport horses

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Mitochondrial oxidative phosphorylation (OXPHOS) plays a critical role in muscle energy production but is also central to diseases, aging, and programmated cell death. While traditional muscle biopsies have provided valuable insights into skeletal muscle physiology, their intrusive nature limits routine use, particularly in elite equine athletes. In contrast, high-resolution respirometry (HRR) offers a minimally invasive approach, requiring only small muscle samples via microbiopsy, to assess mitochondrial OXPHOS, the proccess by which cells produce ATP, the main energy currency, through the transfer of electrons in the mitochondria, driven by oxygen.

Microbiopsies in muscle are performed with a semiautomatic guillotine 14 G needle for soft-tissue biopsy. From 20 to 40 mg of muscle samples are collected and permeabilised for HRR. Mitochondrial respiration is measured during specially designed multiple substrate-uncoupler-inhibitor titration protocols.

Our research focuses on applying HRR to equine muscle microbiopsies to measure OXPHOS capacity across different breeds and training levels. By sampling permeabilised muscle fibres from the *triceps brachii*, we have established reference values for OXPHOS capacity in horses trained for endurance, jumping, eventing, and dressage, as well as in untrained animals. These data highlight the importance of defining fitness-specific reference values, as OXPHOS capacity correlates with training level and body condition. Our reference muscle is the *triceps brachii* because of its mixed fiber type composition but when feasible, the *gluteus medius* is also sampled.

Notably, our studies demonstrate that OXPHOS capacity is predictive of performance in endurance racing, with higher capacities correlating with superior race outcomes. This was particularly evident in a horse who, following pre-race HRR analysis, won the best-conditioned horse prize at the World Equestrian Games. Conversely, reduced OXPHOS parameters were associated with poor performance and undiagnosed pathologies, such as exercise-induced myopathy in French Standardbred racehorses.

These findings suggest that HRR applied to equine microbiopsies offers significant potential for understanding exercise physiology, detecting early signs of muscle dysfunction, and evaluating athletic potential. This approach could be routinely implemented to optimise training programmes and reduce exercise-induced muscle injuries in sport horses.

Electromyographic examinations: indications and how to do it.

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Indications

QEMG proved to be a diagnostic tool in diagnosing generalized neuropathies such as Equine lower motor neuron disease or Equine Grass sickness. The histopathological findings of lower motor neuron abnormalities in these two diseases are described on many occasions by several authors. The EMG evidence of lower motor neuron disease can be an explanation of the similarity in appearance (trembling, muscle wasting, tucked up abdomen, bottom narrow leg position) between EGS and EMND.Generalized (sub)clinical myopathies, myotonic conditions or channelopathies, localized or multifocal myopathies, cervical or lumbo-sacral lesions can be identified using QEMG. Localizing UMN lesions resulting in hypermetric gates is possible. In addition, it identifies the site, origin, severity and distribution of localized lesions.

Quantitative needle EMG also proved to be useful identifying training related neuromuscular adaptations or burden on the neuromuscular system. MUP analysis is a sensitive technique to detect dysfunctional muscle fibres as a causative origin of poor performance horses where muscle enzyme activity was not showing abnormalities. Even when muscle biopsies show no abnormalities yet, the electrical conductance over the motor unit can already detected loss of (functional) muscle fibres contributing to the MUP. Comparing EMG results with histopathological and histochemical analysis of muscle biopsies and necropsies, the quantitative MUPs analysis appeared to be superior in early detection of pathological changes at early stages.

Therapeutic consequences

One of the earlier studies on the value of needle EMG in diagnosing locomotion disturbances of unknown origin showed adding a EMG to the diagnostic workup, changed the clinical decision on cause (neuropathy or myopathy) and location or extension of the lesion (local, multifocal or generalized pathology) considerably. This study elucidated that clinicians seemed to underestimate the cervical area as a potential location of the primary cause and overestimated the pelvic area as the primary location of the lesion. Also, myopathies were overestimated and neuropathies underestimated in this patient group. In many cases where Stringhalt like gait abnormalities were seen, clinicians assumed that neuropathic lesions originated from the pelvic area, but the QEMG was indicative of cervical neurogenic abnormalities in many of these cases. QEMG based diagnosis resulted in changes in the therapeutic interventions, prognosis and content of rehabilitation programs.

A good correlation was found between the- QEMG based - pathological segments and arthrotic lesions found in cervical segments, with concomitant abnormalities in neurological examinations such as mild ataxia, abnormal correction reflexes and mild paresis. On the other hand, cervical disc pathology detected on diagnostic imaging did only correlate in 50 % of the horses with clinical findings and EMG abnormalities in the corresponding segments suggesting that in disc abnormalities were present in many horses without clinical signs. In cases of complex trauma patients, in vertebral arthropathies leading to nerve impingement/ nervous tissue damage in local myopathies or neuropathies identifying the origin and site of the lesions is helpful to fine tune therapies or informing on prognosis.

EMG techniques identified neuromuscular burden on paraspinal muscles of horses placed in different a head and neck positions. The result of the LDR study was that in the round deep an low position of the head with the nose to the chest, significantly more neuromuscular transmission delay could be determined that in the round deep an low position with the head bended to the

carpus. The conclusion of this study was that if training in a LDR position is indicated, the position with the nose towards the fore knee is preferable above the position of the head to the chest (from neuromuscular transmission point of few).

QEMG can detect training adaptations better than advanced biochemical muscle enzyme techniques. It therefore can play a role in determining early stages of overtrained or overreached horses based on the presence of more pathological spontaneous activity. The training adaptations measured by EMG indicated more muscle unit synchronization due to the training and recruitment of larger motor units at a lower stimulus level. Horses in this study showed signs of overtraining/overreaching based on endocrine and performance parameters, whilst their muscles showed signs of upregulation of Glut transporters and some mRNA signals, and the EMG detected signs of muscle training, but not overreaching or overtraining at muscular level.
Needle EMG has played a role in administration of Botox® in the endplate zone in patients suffering from Stringhalt, or in the treatment of laminitis. The effect of Botox® for the treatment of Stringhalt and laminitis was evaluated using QEMG. Research on effective safe dosages for different indications not attractive due to costs involved.

Technique
EMG needle examination is based on intramuscular recording of the motor unit action potential using intracellular electrical conductance or electrical activity generated by the motor unit after central activation. Registration enables (quantitative) analysis of the generated electrical signals. Insertional activity induced by needle placement, presence of pathological spontaneous activity and MUP characteristics are analysed automatic using AI, semiautomatic or manually. The activity starts at low force level muscle contractions to catch the individual MUPs to be followed by evaluation of the interference patterns while muscle force is increasing. In this way primary neuropathy can be distinguished from primary myopathic conditions if mixed MUP characteristics are seen.

QEMG analysis is performed on horses standing in stocks or freely in their stable depending on the situation. Sedation often leads to more difficulty in inducing muscle contractions due to the sedated state, so sedation is not preferred. Insertional activity is evaluated in the muscle at rest. This activity is generated by spontaneously discharging muscle fibres due to the needle placement. In case of muscle fibrosis, it will be absent since no fibrotic tissue will not contain individual muscle fibers that create the MUP. It can also be prolonged if instable muscle fibers are activated by needle placement.

Pathological spontaneous activity (PSA) can be present at rest in various forms such as: fibrillation potentials, positive sharp waves, complex repetitive discharges, (neuro) myotonia or doublets, triplets or multiplets. It can also be induced by muscle contraction. Fibrillation potentials and positive sharp waves can result from myopathies and neuropathies. Neuromyotonia and multiplets are resulting from neurogenic disease and myotonia from specific myogenic disorders such as genetic chloride channel disorders as seen in New Forest ponies.

MUP morphology discriminates between myopathies and neuropathies based on the value of the MUP characteristics described by amplitude, duration, number of phases and number of turns. Reference values of MUPS should be used from age matching healthy horses for each individual muscle measured. Auto-calculations provide the Size index values that differ in certain diseases. Neuropathy is characterized reinnervation that can be recognized as larger, broader, polyphasic or complex motor unit action potentials (MUP). MUPs in the shape of doublets or triplets are indicative of diseased motor neuron nuclei located in the grey matter of the spinal cord.

A myopathic interference pattern is characterized by low amplitude and short duration MUP's. This is the result of loss of individual muscle fibers, that normally contribute to a MUP. Due to this loss, the remaining muscle fibers that contribute to the MUP will be less than normal. This is

recognized as low amplitude, very full interference patterns that are generated at a relative low force. The interference pattern can be poorly filled even at higher muscle force with solitary, or a few large reinnervation MUPs. This can indicate that recruitment at a certain muscle force is suboptimal or absent because of loss of functional motor units. This poor - or absence of interference pattern, is an indication of the lack of possibility to recruit more motor units at a certain muscle force. If the recruitment of MUPs fails at a certain muscle force this absence of ability to induce more MUPS can be a poor prognostic sign for recovery at full force.

Conclusion

Using QEMG, decision making can be facilitated regarding the presence of abnormality, the type of abnormality (neurogenic or myogenic) and/or its location, the severity of the lesion. In any horse in which detailed information about the origin or location of lesion, course of muscle atrophy, or severity of the lesion is needed, QEMG does contribute to decision making. It helps in deciding which therapy is required, in fine tuning the rehabilitation program, or decision making on readiness to increase workload.

RESIDENT FORUM: ABSTRACTS

Use of Freestyle libre 3 for the monitoring of interstitial glucose in horses at rest and at exercise

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Background: Glucose variability has been associated with decreased performance in human athletes; however, its relevance in horses has not been investigated.

Objectives: To evaluate the accuracy of continuous glucose monitoring systems (CGMs) and the effect of sensor placement in equine athletes at rest and at exercise.

Material and methods: Five sport horses in active training were equipped with 2 sensors each, one on the left lower neck and one on the left hindquarter. Horses were fed their usual diet and exercised following a standardized test. Blood was collected at rest and during exercise. CGMs readings were compared to laboratory blood glucose measurements (immunochemistry with Atellica CH, Siemens) using Pearson's correlations and Bland-Altman plots.

Results: The sensors were well-tolerated but 3 had to be replaced. At rest, there was a significant correlation between glucose laboratory measurements and CGM readings when the sensor was placed on the neck ($r^2 = 0.36$) or on the hindquarters ($r^2 = 0.71$); however, during exercise, the correlation was only significant for the neck sensor ($r^2 = 0.32$). The mean bias (95% limits of agreement) between assays ranged from -28.0 (-53.7 to -2.3) mg/dL (hindquarters at rest) to 21.1 (-21.4 to 63.6) mg/dL (neck during exercise).

Conclusions and main limitations: CGMs can be used to assess glucose variability at exercise; however, the sensors can over- or underestimate interstitial glucose and require frequent replacement, limiting their clinical use.

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Competing interests: M. Vernant and S. Lambey are employed by Lambey SA.

Ethical animal research and informed consent: convenience sample, owner's consent was obtained prior to the experiment.

Key manufacturers: SuperSapiens.

Conflicts of interest: "The authors declare no conflict of interest."

New model of disuse-induced bone mineral density loss in horses

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Objective: To determine whether prolonged immobilization in a stall with elevated heels on one forelimb results in a significant loss of bone mineral density (BMD) in the horse's digit and affects the biomarkers of bone metabolism.

Material and methods: Six experimental French trotter horses were kept on stall confinement for 8 weeks, with the last 4 weeks fitted with a wedge on one front foot to raise the heels. CT scans of both forelimbs were performed at the beginning and end of the immobilization period to evaluate BMD. CT image analysis was performed using Image J software. Biochemical monitoring (CTX-I, CTX-II, osteocalcin, PAO, hydroxyproline) was also performed monthly, from day 0 to day 120. Statistical analysis was performed using Wilcoxon Signed Ranks Test.

Results: A significant loss of BMD, measured using CT values (HU), was observed between the beginning and end of the immobilization period ($p<0.005$). In addition, elevation of the heels caused greater distal limb demineralization than on the contralateral limb ($p<0,01$). Evolution of CTX-1 was consistent with BMD changes, with an increase during the immobilization phase followed by a decrease with remobilization.

Conclusions: Two months of stall confinement resulted in a significant reduction in BMD of the distal limb assessed by CT quantification, worsened by heel elevation. CTX-1 was the parameter that correlates best with BMD changes. This new model represents a good alternative to the cast model, which is known to have significant side effects.

Conflict of interest: The authors declare no conflict of interest.

Ethical committee: Approved by the Ethical and Animal Welfare Committee of the French ministry of Education and Research,19th of february 2022 with the number APAFIS #34943-2022012118055143 v1

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Comparison of objective gait analysis system with subjective evaluation of lameness in Thoroughbred racehorses: comparative longitudinal study in a UK racing yard.

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Background: Objective gait analysis is increasingly used by regulatory veterinarian to assess fitness to race; however critical analysis of the technology in relation to gait asymmetry and examination conditions of horses in race training is currently lacking.

Objective: To compare longitudinal data obtained using an objective gait analysis system with concurrent subjective lameness examination by a veterinarian at a UK thoroughbred flat racing yard.

Methods: Longitudinal study in which 113 thoroughbred racehorses in race training at a single UK training yard were evaluated longitudinally over 7 months (February-August 2023). Horses were recorded at trot under standardized conditions using a smartphone-based commercial gait analysis application. Gait was independently evaluated by an experienced racing veterinary surgeon. Statistical analysis determined correlation between objective and subjective evaluation. Trot-up characteristics that might have influenced video analysis were also investigated.

Results: Over seven months, 665 examinations of 113 individual horses took place. Horses were examined a median of 6 times. Results of lameness evaluation with the objective gait analysis and via subjective lameness examination were significantly correlated but did not strongly agree on severity. The K value for degree of asymmetry was 0.258 (0.221-0.294, 95% CI). Correlation between objective and subjective gait analysis was shown to be fair.

Conclusion: Significant differences exist between the objective and subjective lameness evaluation results. Additionally, some trot-up variables appear to influence objective gait analysis results. Repeatability of objective lameness evaluation and effect of acquisition variables are essential subjects for further investigation to validate the usefulness of this gait analysis aid.

Declare conflicts of interest or state “The authors declare no conflict of interest.”
not applicable due to trott-up examinations being routine management practice in racing yards and only involving observation without any veterinary intervention.
This research received no external funding

An anatomical study on inter-individual variation of the tibial nerve and landmarks for perineural anaesthesia in horses.

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Background: Perineural anesthesia of the tibial nerve can be performed ultrasound-guided or blindly, with the latter still being commonly used in equine practice due to practical constraints, despite its lower accuracy and hence, common failure to achieve desensitization. This may be associated with anatomical variations or inadequate landmarks for injection.

Objectives: To examine the course of the tibial nerve in paired cadaver limbs, document anatomical variations, and determine optimal landmarks for perineural injection.

Methods: Dissection was conducted along the medial aspect of the tibia in 10 paired hindlimbs of adult horses of unknown breed and withers height. Thickness of the tibial nerve, localization of its junction with the plantar nerves, and junction with the cutaneous branch were evaluated.

Results: None of the limbs presented anatomical variations of the tibial nerve. Mean nerve thickness was 6±1mm. The junction with the plantar nerves was located at 46±16mm of the calcaneal tubercle. The junction with the medial cutaneous branch was at 79±41mm of the calcaneal tubercle. The mean distance of the tibial nerve to the cranial border of the superficial digital flexor was 11±6mm.

Limitations: Small sample size; difficulties in standardizing limb positioning due to post-mortem constraints.

Conclusion: Problems with perineural anaesthesia cannot simply be attributed to anatomical variations. The large diameter of the nerve and amount of perineural tissue may present specific challenges for adequate desensitization. Our results support the generally recommended site for tibial nerve perineural injection at 100mm proximal to the calcaneal tubercle and 11mm cranial to the superficial digital flexor.

Conflict of interest: None.

Ethical committee: Not applicable due to post-mortem study, horses were euthanized for unrelated reasons.

Sources of funding: This research received no external funding.

ORAL COMMUNICATIONS ABSTRACTS

Can the horse grimace scale be used as an indicator of pain in low-grade lame sport horses at rest?

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Background. Changes in facial expressions can be initial signs of orthopaedic pain. Their detection can help the veterinarian in making an early diagnosis.

Objectives. The study aimed to assess whether horses referred for mild lameness showed any modifications in facial expressions that could help recognise a painful condition at rest

Material and Methods. This case-control study evaluated two groups of horses balanced for age and sex: controls (clinically sound, N=16) and low-grade lame horses (AAEP lameness scale≤3, N=18). For each horse, 1 min video was recorded at rest in their box; videos were then assessed by blind-trained observers using the HGS, a facial–expression–based pain coding system. Mann-Whitney test was used to determine differences between groups. Pearson correlation test evaluated the correlation between HGS and AAEP lameness scale.

Results. The HGS total score was significantly higher in low-grade horses (2.63+/-2.03) compared to controls (1.06+/-1.24) (Mann-Whitney, P=0.026). HGS total score was positively correlated with AAEP lameness score (Pearson correlation coefficient, p=0.004).

Discussion/Main Limitations. Our results found that mild lame horses showed higher HGS values, even at rest, which might be promising for identifying orthopaedic painful conditions; however, further validation might include an HGS assessment after the diagnostic block.

Conclusions. Systematically facial expression changes assessment can be helpful to get an early warning of mild orthopaedic disorders.

Conflict of interests: The authors declare no conflict of interest.

Ethical Committee: The study was approved by the Animal Care and Use Committee of the University of Milan (Prot. N. OPBA_94_2020), and owner-informed consent was obtained.

Sources of funding: This research received no external funding.

Determination of the different phases of the horse swim cycle and correlation to the limbs kinematic obtained by underwater 3D motion capture analysis: preliminary results.

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Background: Swimming is increasingly included in horses' rehabilitation or training programs to maintain their physical condition while reducing weight-bearing stresses on the limbs. To date, the biomechanics of horse swimming is not fully described.

Objectives: To describe the phases and kinematics of the limbs during swimming.

Material and Methods: Underwater 3D motion capture was performed on 6 horses acclimated to swim. Three veterinarians were asked to time subjectively the propulsion (PP) and return (RP) phases, the PP being defined as an active propulsion of the body generated by the limb movement. The 4 limbs were analysed independently, and the corresponding timing of the phases were calculated using the video recordings.

Results: There was a good agreement between veterinarians in the timing of PP (mean difference = 1±4 images, ie <0.04s). Mean duration time of the swim cycle was 1.4±0.1s with PP shorter than RP with a greater difference on hindlimbs than frontlimbs (28±4% vs 33±5% of the swim cycle respectively). PP began at the end of the flexion phase of the elbow and the hip and ended at the end of the extension phase of these joints in all horses for frontlimbs and hindlimbs respectively.

Discussion – Conclusions: Flexion and extension phases of elbow and hip joints seem to represent useful indicators to describe the most active part of the horse swim. This determination of the different phases of the swim cycle will help to define individual horse swimming strategies and evaluate the muscular effects of aquatic training programs.

Conflicts of interest: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Ethics Committee ComEthAnses / ENVA / UPEC (protocol code: 2022-09-19; date of approval: 14 November 2022).

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Acid-base imbalances in Standardbred racehorses after a 2150 m race by traditional and simplified strong ion difference methods.

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Objectives*:* to compare the traditional vs. quantitative acid-base interpretation in Standardbred racehorses competing in a 2150 m race.

Material and Methods*:* Thirteen horses between 3-5 years were included. Venous jugular blood samples were obtained before and 5-15 min after the race. Blood gas analysis was performed within 5 min after extraction with validated point-of-care analysers to determine total solids, pH, PCO_2, PO_2, Na^+, K^+, Cl^- and iCa^{++}, HCO_3^-, base excess (BE), tCO_2, and lactate. Strong ion difference (SID), nonvolatile buffer concentration (A_{tot}), and strong ion gap (SIG) were calculated as previously described. Data are presented as mean and standard deviation.

Results*:* one non-finisher horse was eliminated. At rest, all mean blood values were normal, excluding BE. After the race, blood pH was 7.16 ± 0.05; lactate 15.53 ± 3.51 mmol/l, BE -16.17 ± 3.04 mmol/L, SID 14.45 ± 4.82 mmol/l, and Atot 17.80 ± 1.42 mEq/l. At rest, using the traditional approach, 8/12 horses showed metabolic alkalosis vs. 1/12 with the quantitative approach. After the race, both approaches detected metabolic acidosis in all horses, and 11/12 presented respiratory alkalosis.

Conclusions*:* horses presented acidemia due to mild increase in Atot and marked decrease in SIDm caused by severe lactic acidosis, partially compensated with respiratory alkalosis. These findings are like previous studies in standardbred and polo horses. Although both traditional and quantitative methods have almost the same interpretation after race, quantitative method is preferred because it explains the cause of acidemia and is more accurate in pre-race interpretation.

Conflict of interests: The authors declare no conflict of interest.

Ethical Committee: Not applicable due to prior authorization signed by the people responsible for the horses, and pending approval by the Ethics Committee of the Universitat Autònoma de Barcelona.

Sources of funding: This research received no external funding.

Equine Lameness Detection and Monitoring with an Instrumented Hoof Boot

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Background
Ground reaction forces are considered the gold standard for quantitative assessment of equine lameness but measurements at the hoof are limited to experimental force and pressure mapping devices. The aim was to evaluate whether an innovative instrumented hoof boot was reliable to objectively detect and monitor lameness prior to and after diagnostic anaesthesia.

Materials and Methods
Sixteen horses referred for lameness examination (9 frontlimbs, 7 hindlimbs) were equipped with instrumented hoof boots (Smart Horse Sneaker™, Contitech Deutschland), measuring hoof pressure (HP) including the area under the HP curve (AUC) and body mounted inertial sensors (Equinosis Lameness Locator™). Data were collected simultaneously prior to and after perineural and / or intrasynovial diagnostic anaesthesia until this was considered positive objectively. Wilcoxon's signed rank test was used for statistical analysis.

Results
Median peak HP [N] and median AUC [kNs] of lame and contralateral limbs differed significantly prior to diagnostic anaesthesia ($p=0.0023$ and $p=0.0002$) and not after positive anaesthesia ($p=0.1671$ and $p=0.7057$). The median peak HP and median AUC difference between lame and contralateral limbs differed significantly ($p=0.0015$ and $p=0.0001$) between baseline lameness (HP 8%, AUC 6.5%) and not after positive anaesthesia (HP 3%, AUC 3.5%), respectively.

Main Limitations
Small group size; hoof boot was calibrated ex vivo by manufacturer; in vivo comparison to stationary force plate data pending

Conclusions
The instrumented hoof boot reliably detects primary front- and hindlimb lameness. Monitoring showed that the improvement in lameness after anaesthesia resulted in a more symmetrical distribution of HP and AUC between contralateral limbs.

Conflict of Interest: The authors declare no conflict of interest.

Ethical Committee: The study was approved by the ethics committee of the University of Veterinary Medicine Hannover, Foundation (No. TVO-2023-V-86) in accordance with the responsible German federal state authority (Lower Saxony State Office for Consumer Protection and Food Safety).

Sources of funding: The validation process was partly funded by Contitech Luftfedersysteme, Germany.

Comparison between in hand locomotion and harnessed locomotion in driving horses using a gait analysis system: a pilot study.

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Objectives: Few studies are reported on the locomotion of driving horses. The aim of this pilot study was to objectively compare locomotor asymmetries of single driving horses led in hand or harnessed.

Material and Methods: Twelve driving horses, competing at international level in single category, were equipped with the EQUISYM system (Arioneo, LIM France, Le Bouscat, France) using inertial measurement units sensors. All horses were firstly evaluated in hand in straight line and on a 20m-diameter left and right circle, and secondly while driven with their usual harness and carriage in the same conditions.

Based on the vertical displacement of the head, withers and pelvis, asymmetry indices corresponding to the left-right difference of minimal (AI_min) and maximal (AI_max) altitudes, and of upward amplitude during the propulsion phase (AI_up) were recorded. Differences in asymmetry indices (AI_diff) were evaluated with Wilcoxon's rank test.

Results: Significant differences between in hand vs. harnessed locomotion were only observed in circles: on the right circle at the level of the withers (AI_up_diff=7.9%; p=0.04; AI_min_diff=9.9%; p=0.02) and pelvis (AI_min_diff=8.2%; p=0.01; AI_max_diff=-6.3%; p=0.01) and on the left circle at the level of the head (AI_min_diff=13.4%; p=0.03; AI_max_diff=-17.2%; p=0.001), withers (AI_up_diff=-7.9%; p=0.02) and pelvis (AI_max_diff=8.7%; p=0.005).

Conclusions:
Locomotor asymmetries of these single driving horses were not significantly modified by driving in straight line compared to in hand locomotion. Significant differences in AI were observed in circles, where locomotion of the single driving horse can be more altered by traction and by the shafts of the carriage on each side.

Conflict of interest: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Clinical Research Ethics Committee of the National Veterinary School of Alfort (ComERC n°2023-12-04, March 10th, 2024).

Sources of funding: none.

Functional assessment of coronary haemodynamic response to negative chronotropism

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Background

Horses present better athlete conditions in comparison with other large mammals. However, coronary arteries in horses are not fully characterised, nor are their changes in response to variations in myocardial oxygen demand, which are highly relevant in sport performance. Functional assessment of the coronary arteries is necessary to understand the physiopathology of these arteries and its fundamental role in cardiac oxygenation under different conditions.

Objectives

The aim of this study is to describe the haemodynamic changes of the right coronary artery at rest and after reduction of the heart rate by administration of drugs that produce negative chronotropism.

Materials and Methods

Transthoracic echocardiography was performed in 10 healthy adult horses, at rest (basal), 2, 4 and 6 minutes after inducing negative chronotropism (romifidine administration). Data measured included the internal diameter, blood flow, and output of the right coronary artery in both phases of the cardiac cycle. A Student t-test was performed to assess changes between systole and diastole and a One-way ANOVA test to determine changes between basal conditions and after romifidine administration.

Results

Diastolic blood flow velocity is significantly higher compared to systole. The right coronary artery significantly decreased its diastolic flow velocity after inducing negative chronotropism at all studied time with no statistical differences in the internal diameter and output.

Discussion/Conclusions

The higher diastolic flow velocity is comparable with previous studies performed in other species, where maximal myocardial irrigation occurs during diastole.

Inducing negative chronotropism decreased the coronary flow velocity although coronary output remains unalterable.

Conflict of interests: "The authors declare no conflict of interest."

Ethical committee: protocol code 18/2022, 17th March 2022.

Sources of funding: this research received no external funding.

Autologous conditioned serum benefits inflammatory resolution compared to triamcinolone in a IL-1β synovitis model

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Background and/or objectives:
Synovitis plays a critical role in the development of osteoarthritis. Effective treatment may result in disease modification or improvement of synovial homeostasis. This study compares the effects of intra-articular treatment with triamcinolone (TA) to autologous conditioned serum (ACS) in an IL-1β induced synovitis model.

Materials and methods:

Fetlock joints of six horses were randomly assigned to treatments: PBS, IL-1β (100 ng), ACS, IL-1β+ACS, and IL-1β+TA. Palpation and joint circumference (joint swelling, heat, and effusion scores) and lameness evaluation (lameness locator®) were recorded for 72 hours. Synovial fluid was collected at 0-, 8-, 24-, and 48-hours post-injection (PIH) for cytology, PGE_2 and GAG measurement.

Results:

Although IL-1β+ACS produced the highest synovial total nucleated cell count (40,625±11.01 cells/μL; P=0.001) and TP (3.73±0.63 g/dl) at all time points, lameness was improved when compared with IL-1β. Monocyte percentage increased with ACS treatment at 24 and 48 PIH. At 8 PIH, PGE2 increased in IL-1β treatment but decreased in the IL-β+TA and ACS groups ($P < 0.001$). GAG concentration in synovial fluid was higher at 24 and 48 PIH ($P < 0.001$) for the TA.

Discussion/ Main limitation/ Conclusion:

Both ACS and TA helped to reduce IL-1β inflammatory effects and lameness, but GAG concentration was higher with TA, indicating possible cartilage damage. Increased monocytes by ACS might enhance inflammatory resolution. Limitations of this study include production of a mild, self-limiting synovitis and limited measurement of synovial inflammatory cytokines. ACS could improve pain and aid resolution of inflammation in acute synovitis without chondrotoxicity.

Conflict of interests: the authors declare no conflicts of interest.

Ethical Committee: this study was approved by the Institutional Animal Care and Use Committee (IACUC) at Auburn University (protocol #2017-3043).

Sources of funding: this research was funded by the American Quarter Horse Foundation.

Echocardiography of jumping horses trained for 10 weeks using the water treadmill

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Background and Objectives: Cardiac morphology and function can be affected by training. However, little is known about the effects of water treadmill training (WTT). The aim of this study was to investigate echocardiographic functional indices of jumping horses after WTT for 10 weeks.

Material and Methods: Six trained horses, ~16 years-old, ~578 kg, were evaluated before and after a protocol that included WT (20min, twice/week, water at carpus height) in a well-known exercise sequence for 10 weeks. Animals were under their own control as they had been performing those exercises for more than 6 months. At both evaluations, cardiac ultrasonography was performed with phased array transducer (1.9-4MHz). Short axis right parasternal view of the left ventricle (LV) using the two-dimensional (B-Mode) was obtained, at the level of the papillary muscles, and measurements in M-mode were performed. Interventricular septal thickness (IVS), LV internal diameter (LVID), and LV posterior wall thickness (LVPW) at end-diastole and systole and heart rate (HR) were measured directly. LV fractional shortening (FS), end diastolic volume (EDV), end systolic volume (ESV), LV ejection fraction (EF), stroke volume (SV) and cardiac output (CO) were calculated, based on Teichholz's formula. Data was analyzed using t-test ($p<0.05$).

Results: WTT led to significant increases of IVSd (~2.56 *vs.* ~2.79cm), LVPWs (~4.21 *vs.* 4.48cm), EF (~75.0 *vs.* ~78.6%), FS (~46.8 *vs.* 50.2%) and CO (~16.7 *vs.* ~21.3L/min).

Conclusion: In the studied population, cardiac anatomo-physiological changes were observed, which can be considered adaptations to the imposed fitness program. Further research is necessary to determine how these changes might affect the performance of equine athletes.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Institutional Ethics Committee (CEBEA, FMV, protocol code 28/2023, approved on Oct 20th, 2023).

Sources of funding: This research was funded by Lusofona University / Hidrovet.

POSTER ABSTRACTS

Assessment of Trot-Related Pelvic and Head Movement Asymmetries in Young Horses: Correlations with Intended Use and Forelimb Conformation

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Orthopedic pathologies and associated lameness represent a major cause of retirement among sport horses. In order to assess gait asymmetries, recent years have seen the emergence of gait analysis systems based on wireless sensors, allowing for a detailed quantification of head and pelvic asymmetries during trot. The clinical significance of these asymmetries, sometimes subtle, remains poorly understood, and the factors influencing them are still not well-known. The study presented here was conducted on a population of young warmblood horses (3.95 ± 0.5 years) intended for equestrian sports (eventing (28), dressage (20), endurance (23), and show jumping (24)) and considered healthy by their owners. Individuals were evaluated at trot using a gait analysis system (equinosis© lameness locator), and various conformational traits were recorded. A high prevalence of asymmetries (79%) was observed within the studied population. Furthermore, horses intended for endurance (Arabians and Arabian crosses), of small stature, exhibited significantly more vertical head asymmetries during trotting than the rest of the population ($p<0.05$). Although trends were present, the presence of deviations and asymmetries in the front limbs did not significantly influence the occurrence of vertical asymmetries during locomotion. This study confirms the high prevalence of trotting asymmetries among young horses intended for various disciplines, particularly those oriented towards endurance, as well as a limited effect of limb conformation. Further studies are needed to confirm and assess the long-term impact of these observations.

Conflict of interests: Declare conflicts of interest or state “The authors declare no conflict of interest.”

Ethical committee: Not applicable, as the examination was performed as part of a routine clinical examination.

Sources of funding: his research was funded by a grant from Wallonia.

Association between radiographical, computer tomography (CT) and histopathological findings of 35 front feet with various histopathological grades of chronic laminitis

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Objectives: The objective was to compare radiographic, computed tomography (CT) and histological changes in lamellar tissue concurrent with laminitis. We hypothesized that CT would offer a more accurate representation of changes in lamellar tissue than radiography.

Materials and Methods: Thirty-five front legs from horses that died of causes unrelated to laminitis were used. Evaluation of morphology, radiography and CT were compared with histopathological grading of the sagittal section of dorsal hoof walls. CT and radiographic images of the feet were assessed by independent operators using Syngo.via-software and DICOM. Statistical analysis was performed using R-software. Analyses included Spearman correlation tests and ANOVA.

Results: All hooves were graded 1 or above out of 3 in at least one histopathological parameter. Histological changes in the secondary epidermal lamellae were associated with radiographic changes: decrease in sole depth (P0.03); increased distal phalanx (P3); rotation angle ($P<0.01$); increased distance between the coronary band and the extensor process of P3 (P0.02); increased hoof wall thickness and increased ratio of dorsal hoof wall thickness to P3 palmar length (H:L) (P0.02). Histological changes in the basement membrane were associated with radiography: increased P3 vs. ground angle ($P<0.001$); decreased sole depth (P0.01); hoof wall vs. ground angle ($P<0.001$) and CT changes: corium vs. total hoof wall length (P0.02). A strong positive correlation was noted between radiographic and CT H:L.

Conclusion: Results of the present study support the use of standard radiographic evaluation and a lack of clear advantage in the use of CT in horses with chronic laminitis.

Conflict of interests: The authors declare no conflict of interest

Ethical committee: "The study was approved by the Institutional Review Board (or Ethics Committee) of the Faculty of Veterinary Medicine, University of Zagreb (640-01/24-17/44; 251-61-21/333-21-01)".

Sources of funding: "This research received no external funding".

Synovial, serum and urine biomarkers in osteochondral lesions in young horses: preliminary results

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Background: Knowledge of the metabolism of joint tissue and the molecular factors regulating its normal and pathological homeostasis is needed for the early detection of osteochondritis (OC). To elucidate the molecular basis of OC development, much research effort has been dedicated in recent years to biochemical changes that may occur in the distribution pattern of key molecules in the cartilage matrix in OC. The biomarkers CTXII, COMP, CS846, C2C, and CPII have been extensively studied in the context of equine OC. Together, these biomarkers provide valuable insights into the balance between cartilage degradation and synthesis in horses affected by OC.

Objective: To measure the concentrations of three catabolic (COMP, CTXII, and C2C) and two anabolic (CPII and CS846) synovial biomarkers in young horses affected by osteochondrosis (OC), compared to their levels in control joints, serum, and urine.

Methodology: Fourteen OC-affected horses, aged 1 to 7 years, were included in this study. All horses were referred to the Veterinary Teaching Hospital of Alfonso X el Sabio University for osteochondral fragmentation removal by arthroscopy. Clinical and radiographic examinations were performed beforehand, and synovial fluid from pathological and control joints, serum, and urine were collected to evaluate the concentrations of five biomarkers (COMP, CTXII, C2C, CPII, and CS846) using commercial enzyme-linked immunosorbent assay kits.

Results: All biomarkers were significantly increased in synovial fluid compared to serum. However, no differences were found between OC-affected joints and controls in C2C, CPII, and CS846 levels. CTXII and COMP concentrations were statistically significantly increased in OC-affected joints compared to control joints. Urine levels of COMP, CTXII, C2C, and CPII were significantly increased compared to both OC-affected and control synovial fluids and serum samples.

Conclusions:

1. Biomarker synovial concentrations are higher than in serum, although C2C, CPII, and CS846 levels don't allow differentiation of OC-affected joints. However, COMP and CTXII can distinguish between the synovial fluid of OC-affected and control joints.
2. Urine concentrations show higher levels compared to OC-affected and control synovial fluids and blood. For this reason, urine is considered an ideal non-invasive sample, as it is usually plentiful and poses minimal risk for collection.

Conflict of interests: The authors declare no conflict of interest.

Ethical Committee: The study was approved by the Ethics Committee of Alfonso X el Sabio University (protocol 2022_3/142 in May 2022).

Sources of funding: This research was funded by Fundación UAX-Santander.

Is dry needling an effective technique to treat pain from trigger points in the equine brachiocephalic muscle?

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Introduction

Trigger points (TrPs) are painful and hyperirritable spots located in a taut band of skeletal muscle. In humans, dry needling is effective for reducing pain from TrPs. Algometry (Alg) is reliable in evaluating TrPs in the equine braquiocephalic muscle (EBM). TrPs in equine musculature has been confirmed. It is unknown if dry needling could be an effective treatment for TrPs pain.

Objectives

To investigate whether dry needling could be effective for EBM TrPs pain.

Materials and methods

TrPs from EBM were evaluated in 98 horses, of which 66 were randomly assigned to the treatment group (TG) and 32 to the control group (CG). None of them had orthopedic pathology or pharmacological treatment. After locating the TrPs and measuring the mechanical nociceptive threshold in the equine EBM with an algometer, a physiotherapist applied dry needling to the TG once a week for 3 weeks. The same palpation and measurements were performed on CG, but no dry needling was applied. Alg measurements were performed by the same physiotherapist, blinded to results, before treatment, immediately after treatment, at 4h, 24h, and 72h/per week for 3 weeks. Alg data were analyzed using generalized linear mixed models. The Tukey test was used as a post-hoc test.

Results

Alg values were significantly ($P<0.001$) influenced by treatment and time factors and their interaction. Horses from TG showed significantly lower Alg values than animals of the CG at any time.

Conclusion

Dry needling has shown to be effective reducing Alg values in EBM in the short term.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: Ethical approval was obtained from the CEEAH from UAB (Protocol Code 5618. June 2021).

Sources of funding: This research received no external funding.

Use of a horse walker training protocol for jumping horses

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Background and Objectives: Training programs must improve the physical conditioning of athletic horses, while simultaneously preserve their well-being. Horse walkers are used extensively in the management and training, as allow multiple horses to be exercised simultaneously in a controlled fashion. Therefore, the aim of the research was to evaluate the effectiveness of a seven-week training program, using an automated horse walker for jumping horses.

Material and Methods: Four trained horses, ~14 years-old, ~582.3 kg, were evaluated before and after a training protocol that included the horse walker (1h, twice/week, at weekly increasing speeds, starting at 1.7 km/h in S1 and ending at 7 km/h at S7) to a well-known sequence of exercises for 7 weeks. Animals served as their own control as they have been performing those exercises for more than 6 months. On both occasions animals were examined through a jumping field test before and after the exercise and at 30 min and 240 min of recovery, when heart rate, respiratory rate, body temperature, total blood cell count, blood lactate and glucose, serum proteins, albumin, AST and CK were determined. During the exercise animals used a HR monitor (Polar H10) and from these data, energy expenditure was calculated using specific formulas. Data was analyzed using Tukey and t-tests ($p<0.05$).

Results: Higher values of MCHC and lower values for MCV, cortisol, total WBC count and neutrophils count were observed after the training period.

Conclusion: Although the limited number of horses, the proposed protocol maintained the pre-existing physical conditioning while possibly improving the psychological well-being, as cortisol levels dropped after the training.

Ethical committee: The study was approved by the Institutional Ethics Committee (CEBEA, FMV, protocol code 27/2023-4, approved on Feb 7th, 2024).

Conflict of interests: The authors declare no conflict of interest.

Sources of funding: This research was funded by Lusofona University / Hidrovet.

Quantitative gait analysis with Alogo Move System in jumping horses trained for 10 weeks using the water treadmill

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Background and Objectives: Water treadmills (WT) are widely used in rehabilitation centres and professional training establishments worldwide. However, exercise programmes used to date have been based on limited evidence as relatively little is known about the kinematics of movement in water. Therefore, the aim of this research was to study the effects of a WT training program on selected jumping parameters of horses.

Material and Methods: Six trained horses, ~16 years-old, ~578 kg, were evaluated before (M1) and after (M2) a training protocol that included the WT (20min, twice/week, water height at the carpus) to a well-known sequence of exercises for 10 weeks. Animals served as their own control as they have been performing those exercises for more than 6 months. On both occasions the horses' kinematics were evaluated through a show jumping field test while wearing a triaxial accelerometer with GPS-based inertial measurement unit (Alogo Move ProTM) attached mid-ventrally to the girth. Data was collected and processed using the Alogo software, interpretating separately vertical and oxer jumps. At both evaluations, we determined the angles between the ground and the highest point of the withers and croup (take-off) and maximum value of the acceleration per stride (strike power). Data was analyzed using t-test ($p<0.05$).

Results: After the WT training, higher values were recorded for stride power (M1 vs.M2) (~2.5G *vs.* ~3.2G) and take-off angle for the vertical jumps (~20.0º *vs.* ~24.5º) and for the oxer jumps (~21.7º *vs.* ~26.1º).

Conclusions: Horses showed improvements in forehand elevation and stride power at take-off, both of which have been shown previously to contribute to jumping success.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Institutional Ethics Committee (CEBEA, FMV, protocol code 28/2023, approved on Oct 20th 2023).

Sources of funding: This research was funded by Lusofona University / Hidrovet.

Energy expenditure of jumping horses trained for 10 weeks using the water treadmill

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Background and Objectives: The potential benefits of water treadmill training (WTT) are based on the buoyancy, viscosity and hydrostatic pressure characteristics of the water. The physiological effects of WTT are known to vary with water height and the speed, duration and frequency of training but the responses to manipulation of these variables are not fully understood. Thus, the objectives were to study the effects of a WTT on energy expenditure of jumping horses.

Material and Methods: Six trained horses, ~16 years-old, ~578 kg, were evaluated before (M1) and after (M2) a training protocol that included the WT (20min, twice/week, water height at the carpus) to a well-known sequence of exercises for 10 weeks. Animals served as their own control as they have been performing those exercises for more than 6 months. On both occasions animals were examined through a show jumping field test using a HR monitor (Polar H10) and from these data, energy expenditure (EE), cost of transport (COT) and metabolic power (Pmet) were calculated using following formulas: EE (J/kg/min) = 0.0566 x $HR^{1.9955}$, COT = (HR_{effort}–HR_{basal})/kg/m x10^3 and Pmet = (HR_{effort}-HR_{basal})/min/kg. Data was analyzed using t-test ($p<0.05$).

Results: Significant improvements were observed for EE (M1 *vs.* M2) (1000.3 *vs.* 573.5 J/kg/min) and COT (0.428 *vs.* 0.237 beats/kg/m x10^3), with animals reaching higher speeds (12.9 km/h *vs.* 17.0 km/h) after the training program. No changes were observed for Pmet.

Conclusion: These data confirm that the proposed WTT protocol improved energetic efficiency.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Institutional Ethics Committee (CEBEA, FMV, protocol code 28/2023, approved on Oct 20th 2023).

Sources of funding: This research was funded by Lusofona University / Hidrovet.

Effect of jumping fences on heart rate, blood lactate and CK activity in show jumpers.

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Background and objectives: Exercise testing in show jumpers can be required for medical or training purposes. The effect of jumps on some physiologic parameters is poorly described. We wanted to compare the effect of one training session on the flat (TEST1) and one including 1.30 m jumps (TEST2) on velocity, heart rate (HR), blood lactate (BL) and creatine kinase (CK) in show jumpers.

Material and methods: Ten show jumpers (8.2 ± 1.99 y.o.) were recruited. Velocity and HR were assessed using Equisense® and Televet® systems, respectively. Blood was recovered to measure BL and CK before, during and after exercise. Statistical analyses consisted of ANOVA and T-tests.

Results: Specific velocities and HR values on the flat (between fences for TEST2) were not significantly different between the tests. In TEST2, there was a significant increase in HR during the suspension phase over jumps compared to HR during canter between fences. The concentration of CK did not differ between the tests and was not modified by exercise in any session. In both TEST1 and 2, BL concentrations were below 2 mmol/l with no significant increase.

Discussion and conclusions: In our study, jumping training did not modify BL, HR and CK values compared to an equivalent (in speed and duration) flat training. Only HR values were significantly higher during the suspension phase of the jump compared to mean HR when cantering between jumps. These results have to be taken into account when performing an exercise test or planning a training schedule for show jumpers.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Ethics Committee of the University of Liège (approval n°23195)

Sources of funding: This research received no external funding.

Focal myopathy in the proximal limb causing forelimb lameness: a case series

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Background-Objective: Focal myopathy lesions were identified as primary cause of proximal forelimb lameness. This retrospective study aims to present 4 cases.

Material and methods: Three horses and one pony, aged 6 to 13 years, performing in showjumping or dressage examined for forelimb lameness and with a diagnosis of focal myopathy in the proximal forelimb were selected. Complete diagnostic work-up included dynamic examination, nerve blocks to exclude other causes of lameness, and imaging investigations.

Results: For 3 out of 4 horses, clinical examination included intermittent but intense forelimb lameness with a reduction of the cranial phase of the stride. A focal myopathy was identified in all 4 horses on the ultrasonographic examination. In one horse who also underwent scintigraphic examination, an increased radiopharmaceutical capture was detected at the level of the injured muscle. The affected muscles were the subclavius (3/4 horses) associated with the pectoralis descendens in one horse, and the extensor carpi radialis in one horse. Ultrasound abnormalities were characterized by one or more diffuse echogenic areas involving few muscle fasciculii. The prognosis was rather good after a few weeks of rest and rehabilitation, and for 2 horses with the administration of muscle-relaxing drugs, manual mobilization and physiotherapy.

Discussion-Conclusion: The focal increased echogenicity in muscles injured was different from rupture or hemorrhage, which are characterized by hypoechogenic areas. Histologic studies would be necessary to determine the precise nature of these lesions.

Although uncommon, focal myopathy in the proximal forelimb, should be considered in the differential diagnosis of lameness.

Conflict of interest: The authors declare no conflict of interest.

Ethical committee: Not applicable due to retrospective analysis of clinical data.

Sources of funding: This research received no external funding.

Successful surgical management of chronic desmopathy of the tarsal short lateral collateral ligament (SLCL) in a sports pony

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Introduction: Primary tarsal collateral desmopathies are not uncommon in horses but diagnosis is challenging and prognosis can depend on severity of the lesion and on the development of associated osteoarthrosis.

Objectives: To describe the positive outcome of a chronic desmopathy of the tarsal short lateral collateral ligament (SLCL) associated with an intrasynovial granuloma and tarsocrural osteoarthritis.

Material and Methods: An 8-year-old sports pony was presented with left hind lameness and tarsocrural joint effusion of 2 weeks' duration. Lameness, radiographic and ultrasonographic examinations were performed.

Results: A moderate focal desmopathy of the SLCL of the left tarsus was diagnosed ultrasonographically. After two months of conservative treatment, ultrasonographic deterioration of the desmopathy and developing radiographic signs of tarsocrural osteoarthritis changes were observed. Tarsocrural arthroscopy was performed identifying a large granuloma on the intra-articular portion of the proximal attachment of SLCL. Following debridement with a synovial resector, a gradual rehabilitation program allowed the pony to become sound, with mild positive flexion test and return to ridden exercise eight months after surgery.

Discussion and conclusion: Torn ligament fibers associated with granuloma formation have been identified arthroscopically as a perpetuating cause of articular inflammation in the tarsocrural joint. Although ultrasonography is essential to diagnose tarsal soft tissue injuries, arthroscopy is superior to identify, evaluate and treat intra-articular fiber tearing with tissue protrusion and synovitis. In conclusion, this case report highlights the potential role of arthroscopy in obtaining a positive outcome for tarsal SLCL desmopathy, even when the severity of the lesion is associated with early osteoarthritis development.

Conflic of interests: Declare conflicts of interest or state "The authors declare no conflict of interest."

Ethical committee: Not applicable, it is a case report

Sources of funding: This research received no external funding.

Are gait quality and conformation scores of young Warmblood horses associated to vertical motion asymmetry at the trot?

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Background: Associations between orthopaedic health, longevity, and conformation in horses, are important to study to promote sustainable breeding. The "young horse tests" (YHT) provide Linear Profiling assessments of conformation, gait, jumping and behavioural qualities, but objective gait assessment is not used.

Objectives: To investigate associations between scores in the YHT and the degree of vertical movement asymmetry in 3-year-old Swedish Warmblood horses using objective gait analysis.

Material and Methods: A total of 116 three-year-old Warmblood horses were recruited at five YHT events. Based on pedigree, each horse was categorized as Jumping, Dressage, All-round or Thoroughbred. Trait scores from the YHT were transformed into 18 talent scores according to Nazari-Ghadikolaei et al. (2023). Measurements of vertical motion asymmetry were performed using a smart phone application as the horses were trotted in a straight line on a flat surface. From the four asymmetry parameters retrieved from the measurements, three mean asymmetry metrics were calculated for each individual: forelimb asymmetry, hindlimb asymmetry and total asymmetry.

Results: The total asymmetry was significantly (ANOVA, $p < 0.01$) lower in Dressage compared to Show Jumping horses. Seventeen significant correlations (Pearson's method) between asymmetry metrics and YHT score factors were found and used in linear models. Fourteen YHT score factors significantly ($p \leq 0.05$) explained the objective asymmetry values. These factors consisted of one jumping factor, three conformational factors and ten gait related factors.

Conclusions: Better gait scores for walk and trot during YHT were associated with a lower degree of vertical movement asymmetry in this limited study population.

Conflict of interests: The authors declare no conflict of interest for this study, but Dr. Hernlund is a founder of Sleip AI, the method used for objective gait analysis.

Ethical committee: The study includes no invasive methods. Horse owners gave their written consent to participation in the study. The study was approved by the Ethics committee, no. 5.8.18.15533/2018 Date 2018-11-13 active to Oct 22 2023.

Sources of funding: This research was funded by Elsa Paulssons Minnesfond.

Assessment of the use of a handheld myotonometer for objectively quantify tone and stiffness of the horse's neck.

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Background. Muscle tone and stiffness are subjectively scored in horses.

Objective. Assess the potential use of a handheld myotonometer in the neck.

Materials and methods. Tone and stiffness were measured in nine non-sedated horses (4 mares, 5 stallions), without lameness, cervical or thoracolumbar pain with MytonPro® at the level of 3rd, 4th and 5th (C3, C4, C5) vertebrae on both neck´s lateral sides. Three immediate consecutive measurements were made by observer 1. Measurements were repeated one week later by the same observer, and by observer 2. Intra-class coefficients (ICC) were interpreted as: Moderate ICC 0.50-0.75; Good 0.76-0.90; excellent >0.90. Friedman and Wilcoxon tests assessed differences between the three measurements of observer 1. Kruskall-Wallis and Mann-Whitney tests evaluated differences in lateral sides of the neck at C3, C4, and C5 and between both observers. Significance was at $p<0.05$.

Results. No significant differences were found between the three measurements of observer 1 (ICC>0.821 and 0.893, for tone and stiffness). Greater tone and stiffness were found in C4 and C5 compared to C3 on both sides. Lower stiffness was found in C5 left than right. Differences were found in C4 (right side) when comparing the measurements made by observer 1 with one week of separation, with ICC moderate-good (>0.680 and 0.832 for tone and stiffness). Minor significant differences were found between both observers, and reproducibility was sometimes low (ICC>0.475 and 0.402 for tone and stiffness).

Conclusions. Myotonometric measurements of muscle tone and stiffness are reliable but less reproducible. Comparison with clinical examination is required.

Conflict of interest: Authors declare no conflict of interest.

Ethical committee: Not applicable. The procedure does not cause any harm to the animals and sedation was not required.

Sources of funding: Research group AGR-111 of the University of Córdoba, Spain.

Longitudinal field study reveals routine blood biochemical markers inadequate to indicate musculoskeletal injury risk in jump racing Thoroughbreds

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Background and Objectives: Musculoskeletal injuries (MSIs) are a major welfare concern in the horseracing industry. This longitudinal study examines routine blood biochemical markers in jump racing Thoroughbreds to determine whether changes occur in subclinical horses that will experience MSIs.

Materials and Methods: Morning blood samples were collected bimensually from racehorses, at rest, pre-feeding, in three French training stables over 18 months. The case group (n = 13, including 7 bone fractures and 6 tendonitis) and matched controls (n = 10, matched for stable, sampling day, training regimen, age, sex, etc.) were sampled 4±2 times (mean±SD) consecutively. Injuries to affected horses manifested within two months post-final sampling. Analysed biochemical parameters included GGT, SDH, GLDH, AST, ALP, albumin, CK, cholesterol, SAA, bilirubin and bile acids. Statistical analyses involved the Wilcoxon test, chi-squared tests, and two-way ANOVA-type nonparametric analysis for longitudinal data.

Results: No statistically significant differences were found between cases and controls across measured parameters. However, temporal fluctuations were observed in several blood markers. Notably, there was a significant decrease over time in ALP levels across all groups. Additionally, the patterns of changes in total and indirect bilirubin, as well as cholesterol levels, were significantly different, with an increase observed in tendonitis cases *versus* a decrease in fracture cases, all within normal ranges.

Discussion and Conclusions: Although variations have been observed over time for certain parameters, they may reflect individual physiological changes rather than annunciating upcoming injury. In conclusion, advanced technologies, such as "omics", need to be implemented to find relevant biomarkers.

Conflict of interest: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Ethics Committee of the University of Liège (n°22-2480, 11/07/2022).

Sources of funding: This research was funded by the FNRS (Fonds de la Recherche Scientifique), the IFCE (Institut Français du Cheval et de l'Équitation) and the University of Liège (Fonds Spéciaux pour la Recherche).

Are gait quality and conformation scores of young Warmblood horses associated to vertical motion asymmetry at the trot?

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Background: Evaluation under tack is an important part of the lameness exam. If the rider chooses rising trot (posting), a study of 26 horses has shown an effect on vertical motion asymmetry of the pelvis, but less clear results for the head.

Objectives: To investigate the effect of rising trot on vertical motion asymmetries in a larger sample of riding horses.

Material and Methods: In total 125 horses were recorded with a smartphone gait analysis application when being trotted in a straight line in hand without a saddle, ridden in right rising and in left rising trot. Recordings with <15 strides were excluded, leaving 242 trials from 89 horses for analysis. The within-horse difference in head and pelvis impact and push-off asymmetries between the three conditions were calculated and tested (≠0, Wilcoxon Signed Rank test).

Results: Significant differences were found for all conditions ($p>0.02$). On the "sitting diagonal" the downward displacement of the horse's pelvis decreased while the head was lowered more. As the rider rose from the saddle, the horse's pelvis was not coming up as high while the head became more elevated.

Conclusions: Equine orthopaedic clinicians should be aware of the systematic effect that the rising trot has on vertical motion asymmetries of both head and pelvis of the horse during lameness assessment under tack. These asymmetries should not be mistaken for indicators of lameness.

Conflict of interests: The authors declare no conflict of interest for this study. Dr. Hernlund is a founder of Sleip AI, the method used for objective gait analysis.

Ethical committee: The study includes no invasive methods. Horse owners gave their written consent to participation in the study. The study was approved by the Ethics committee, no. 5.8.18.15533/2018 Date 2018-11-13 active to 2023-10-22.

Sources of funding: This research received no external funding.

Computed tomographic examination of the proximal metatarsal region and tarsus in standing sedated horses – a review of 21 cases

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Objectives: To document the feasibility and diagnostic value of computed tomographic (CT) examination of the proximal metatarsal region and tarsus in standing sedated horses.

Materials and methods: Clinical records and CT studies of horses undergoing fan-beam CT examination (Qalibra CT) of one or both hocks and/or proximal metatarsal regions (January 2021 - March 2024) were analysed (retrospective descriptive study) by an ECVSMR Diplomate.

Results: Twenty-one horses were included, the majority were mature Warmbloods, there was one Warmblood yearling, one Quarter Horse and one pony. Indications for CT examinations included: lameness localised to the proximal metatarsal and/or distal tarsal region (n=12), severe tarsocrural joint effusion with (n=4) or without (n=1) associated lameness, trauma to the hock or the proximal metatarsal region (3), severe tarsal sheath effusion (n=1). The procedure was well tolerated, and diagnostic quality images were achieved in all cases. Of the 10 horses with lameness abolished by perineural analgesia of the deep branch of the lateral plantar nerve, in five, significant osseous changes in the distal tarsal and/or tarsometarsal joint were identified. In 3/5 distended tarsocrural joints, a large subchondral bone lesion was seen in the distal intermediate ridge of the tibia, in the proximal talus and in the distal talus and proximal central tarsal bones. Computed tomography provided additional information over radiography in all these cases.

Main limitations: Small sample size, images were not assessed blinded.

Conclusions: CT of the hock and proximal metatarsal region can be performed in standing sedated horses and can provide useful information in selected cases.

Conflict of interest: The authors declare no conflict of interest.

Ethical committee: Not applicable because CT examinations were performed with a clinical indication.

Sources of funding: Part of the study was funded by the 'Young researcher internal grant' of the University of Veterinary Medicine Budapest.

The effect of the clinical environment on lameness severity in horses

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Background: Horses are prey animals and show less pain behaviour when observed by humans. Stress may reduce their perception of pain, and it is not known how lameness is affected by the clinical environment which can be stressful.

Objectives: To investigate the effect of the clinical environment on lameness severity in horses.

Material and Methods*:* Thirty-three lame horses of different breeds, gender and age were included in the study. Motion analysis using a smartphone application was performed at the clinic during a lameness examination and in the horse´s home environment the day before. Vertical motion asymmetry of head and pelvis were calculated during straight line trot and lungeing. Differences in motion asymmetry were statistically tested (Wilcoxon signed-rank test) between measurements in the home and clinical environment.

Results*:* The forelimb lame horses showed significantly less lameness on the straight ($p=0.007$) and during lungeing ($p=0.001$) at the clinic compared to the home environment while there were no statistical difference for hindlimb lameness.

Discussion*:* The decreased lameness degree found in forelimb lame horses could be due to several factors. Either the horses experienced less pain or experienced stress, which influenced the head carriage during locomotion. The non-significant results for the hindlimb lame horses were potentially related to the small sample size.

Limitation: Differences in surface type may influence the results.

Conclusions: During lameness assessment in the clinic, the potential effect of environmental stress should be considered. Remote assessment at home can give improved diagnostic information for subtle lameness cases and stress sensitive individuals.

Conflict of interests: Declare conflicts of interest or state “The authors declare no conflict of interest.”

Ethical committee: The study was approved by the Ethics committee, no. 5.8.18.15533/2018 Date 2018-11-13 active to 2023-10-22.

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Inter- and intra-individual variation in forces applied during the distal forelimb flexion test

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Background. Flexion tests are commonly used in lameness and pre-purchase examinations although their reliability is controversial. Considerable inter-individual variation in distal limb flexion test force has been documented; however, data regarding intra-individual variation is scarce.

Objectives. To evaluate inter- and intra-individual variation in flexion force during the distal forelimb flexion test.

Methods. Eight veterinarians performed 3 consecutive 60-second distal forelimb flexion tests with 10 min intervals in both forelimbs of one horse using a patented force measuring device. The device consisted of a 3D printed hoof rest and handle with integrated electronics. Test were repeated in >4 weeks. Examiners were blinded for the measurements. Intra-individual differences in force were assessed with mixed models and matched pairs test (P<0.05). The coefficient of variance (CV) in force was calculated per examiner.

Results. Mean (and total) force applied per test ranged from 5.4 kg (326 kg/min) to 18.2 kg (1092 kg/min). There were significant differences in mean flexion force between examiners (P<0.001); between tests per day within examiners (P< 0.001); and between days within examiners (P<0.001). For 7/8 examiners, there were significant differences between sides (P<0.003). CV ranged from 10.4% to 18.9% (mean 14.4%).

Limitations. The technique adjustment necessary for using the device could represent a confounding factor.

Conclusion. This study demonstrated large inter- and intra-individual variations in applied flexion forces when performing the distal forelimb flexion test. The differences between sides and days cannot easily be explained by the adjusted technique and could potentially be of clinical relevance when performing lameness workups.

Conflict of interest. Nothing to declare.

Ethical committee. The study was approved by the institution's ethics committee (reference 14/04723-86).

Sources of funding. Medodan Movotec AS provided the PSAD® measuring device.

Preliminary study: incidence of dorsal spinous process impingement and its impact on spine extension in a group of show jumping horses.

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Objectives. Dorsal spinous process impingement (DSPI) is a common cause of back pain and of poor performance in sport horses. This study aimed to evaluate the radiographic incidence of DSPI in a group of show jumping horses with back pain and correlated these findings with range of thoracolumbar extension and age.

Material and Methods. Twenty-eight horses, ~17 years, underwent radiographic and thoracolumbar spine extension reflex evaluation. Measurement of each intervertebral space (T7-L4) was performed using the JiveX software, according to *de Graaf et al*. (grade 0 to 3). Extension reflex was quantified with reflective markers at T12 and T18, recorded using a camera set at 2m. Videos were analyzed using Kinovea® and MATLAB software. Statistical analyzis used the Shapiro-Wilk and Spearman test($p<0.05$).

Results. In this population, the incidence of DSPI was 100%, with the T16-T17 joint being the most affected (93%). The most severe lesions were detected between T15-T16-T17. Mean extension range at T12 was 3.17 cm (±2.27) and at T18 was 3.65 cm (±2.29). A moderate correlation was found between age and the degree of DSPI at T17-T18 ($p=0.003$; $rho=0.554$). A negative correlation was observed between age and extension at T12 ($p=0.0003$; $rho=-0.6378$) and extension at T18 ($p=1.191e^{-0.5}$;$rho=-0.7267$), as well as between T18 and lesion grade T17/T18 ($p=0.021$;$rho=-0.4336$).

Discussion/Conclusions. In the studied population, increased age and poor back mobility can be correlated with the radiological score of DSPI. Kinematic analysis of thoracolumbar extension may be a useful tool in the management of DSPI, although further research is needed.

Conflict of interests: The authors declare no conflict of interest.

Ethical committee: The study was approved by the Institutional Ethics Committee (CEBEA, FMV, protocol code 09/2024).

Sources of funding: This research was funded by Lusofona University / Hidrovet.

Effect on tissue perfusion in horses after capacitive resistive electrical transfer therapy in inflamed and non-inflamed areas assessed by scintigraphy

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Background. The application of 448 kHz capacitive resistive electrical transfer therapy (CRET) has demonstrated enhanced vascular perfusion and oxygenation in superficial tissues.

Objective. Assessment of scintigraphic vascular changes after CRET in tissues.

Materials and methods. Three experiments: 1) Moderate thermal intensity CRET was administered to a forelimb of a horse, followed by scintigraphy immediately after CRET, with images taken 15 and 30 minutes later; 2) Induced subcutaneous peritendinous inflammation (5% iodized solution) in both forelimbs of a horse, followed by three days of low subthermal intensity CRET, and scintigraphy immediately, 15 and 30 minutes after last session; 3) Same protocol as 2, but inflammation was induced in two horses with 10% iodized solution, followed by two days of CRET and scintigraphy. Contralateral forelimbs in experiments 2 and 3 were used as control.

Results. At the three scintigraphic evaluation times, an increase in radiopharmaceutical uptake density (RUD) of 175.9, 31.9 and 17.9% was found in experiment 1 in the treated forelimb compared to the untreated forelimb. In experiment 2, the inflamed treated area experienced a lower scintigraphic RUD compared to control (4.8%, 18.9%) 15 and 30 min after CRET. In experiment 3, the inflamed limb treated with CRET reduced RUD compared to the untreated limb (26.3, 37.05%) 15 and 30 minutes after last CRET session.

Conclusions. Limited number of horses. Scintigraphy is a useful method for assessing changes in tissue perfusion after CRET. Moderate thermal intensity CRET increases blood perfusion, but in inflamed areas, CRET at low subthermal intensity reduces blood perfusion, which might limit the inflammatory process.

Conflict of interest: Authors declare no conflict of interest.

Ethical committee: 2023PI/17 Approved by the University of Córdoba, Spain.

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Supraspinous ligament desmopathy (SSLD) as cause of back pain in 8 horses.

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Background. Back pain can cause poor performance in horses. There are many causes relating to pathologies of osseous and soft tissue structures such as supraspinous ligament (SSL). Clinical findings and prognosis in horses with SSL desmopathy (SSLD) has never been reported.

Objectives. To report clinical and diagnostic imaging findings, treatment, outcomes in horses with SSLD.

Material and Methods. Medical records were retrospectively reviewed between 2017-2023. Horses diagnosed with SSLD by ultrasonographic examination and follow-up ≥12 months were included.

Results. Eight horses met inclusion criteria: three Irish Sport horses, two Connemaras, two Warmbloods, one Welsh Cob. Horses performed general riding (three), showjumping (three) and eventing (two). Clinical signs were only observed under saddle and included bucking, reluctance to go forward and canter. Lesions were identified between the 11th thoracic (TV) and 1st lumbar vertebra. The onset was acute in seven cases (87.5%), chronic in one (12.5%). On ultrasound, lesions appeared as focal anechoic/ hypoechoic area, SSL cross-sectional area was increased. SSLD was the only back pathology except for the horse with chronic SSLD, who presented impingement of the dorsal spinous processes between 14th and 18th TV. However, their clinical significance was excluded by diagnostic analgesia and refractoriness to treatment. Treatment included rest, rehabilitation (strengthening program), extracorporeal shockwave therapy. Horses with acute onset had excellent outcome, the chronic case was retired. The prognosis for athletic activity was good (87.5%).

Main limitations. Retrospective clinical study, small population.

Discussion. Although rare, SSLD should be considered as differential diagnosis for back pain. Horses with acute SSLD return to athletic activity after treatment and rehabilitation.

Conflict of interest: authors declare no conflict of interest.

Ethical committee: Not applicable due to the fact it is a retrospective clinical- no ethical approval required.

Sources of funding: None required.

Ultrasonographic measurement of the equine diaphragm muscle size in a 3 day event population.

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Objective. Diaphragm is an important respiratory muscle playing a key role during exercise. This study aimed to test diaphragm thickness to a 3-day-event horse population. It was hypothesised that the diaphragm thickness would be influenced by age, sex and level sport activity.

Materials and methods. Sixty eventing horses in full activity, 20 for each level of sports activity (low: CCI/CIC*, medium: CCI/CIC**, high: CCI/CIC***/****), were included. There were 21 females and 39 geldings and the mean age was 10.1±3.1. Diaphragm thickness was measured ultrasonographically at ICS 10, 11, 12 at peak inspiration and expiration, on left and right side.

Correlation between diaphragm measurements and age was evaluated by Spearman Rho coefficient. Two-way ANOVA was used to test for differences in thickness among level of sports activity with Bonferroni as *post-hoc*. Paired Student't test was used to compare the left and right measurements. Significance was set at $p<0.05$.

Results. Age was significantly higher for high and medium level compared to lower; however, no correlations were found between age and diaphragm thickness, neither with sex ($p>0.05$). The measurements of the diaphragm obtained on the left side were thicker than that of the right. The thickest measurements were at ICS 10 and 11 on the left side during inspiration (1.2±0.2 cm). High and medium level horses have a significantly thicker diaphragm compare with low level horses ($p=0.008$).

Conclusion. Thickness of the diaphragm seems to be influenced by the level of sports activity in eventing horses, independently from the age and the sex.

Conflict of interest: Declare conflicts of interest or state "The authors declare no conflict of interest."

Ethical committee: Not applicable

Sources of funding: This research received no external funding.

Outcome of ultrasonographically identified muscle tears

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Introduction: Muscle strain and tear occurs due to mechanical disruption of muscle fibres. Research on this pathology in equids is limited, and diagnosis is often presumptive without evidence of structural damage with imaging. The aim of this study was to investigate muscle damage in horses confirmed by ultrasonography and to describe clinical and diagnostic findings and evaluate outcome.

Material and methods: Clinical records of horses treated by the Royal Veterinary College were retrospectively analysed; selecting cases in which muscle strain or tear was the only injury and the diagnosis confirmed with ultrasonography. Clinical records contained qualitative description of the patients' clinical signs and ultrasonographic findings. Quantitative analysis of these data was performed to determine the statistical significance of any link between signalment and incidence or outcomes.

Results: Eight cases were included. Age and sex had no significant effect on incidence, although stallions and geldings presented at a younger age than mares. Forelimb and hindlimb injuries were equally represented, with the right forelimb accounting for the most cases (n=3 each). With one exception a single muscle was affected in each case. Hindlimb injuries were associated with longer recovery periods (mean 216.3 days, compared to 27.3 days for forelimb injuries, this relationship was significant using an unpaired t test ($p=0.0330$)). 7 horses were lame and 6 exhibited visible or palpable swelling. All horses survived and information on follow up examination was available for 7. In every case clinical sign resolved with conservative treatment, and in 6/7 (86%) cases a return to previous or greater level of work was achieved. Recovery from clinical signs varied from 12 to 291 days (mean 116.6 days).

Limitations: The retrospective nature of the study meant a small sample size was available for analysis.

Conclusion: This study identified that muscle damage, confirmed ultrasonographically, was a rare diagnosis but that the prognosis was excellent with conservative management alone.

Conflict of interest: Declare conflicts of interest or state "The authors declare no conflict of interest."

Ethical committee: Ethical review performed by the Royal Veterinary College Clinical Ethical Review Board

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A survey on equine mesotherapy by equine practitioners: indications, use, products and complications.

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Background. Mesotherapy is used by equine practitioners but a clear description of most common indications, a standard protocol, and complications is lacking in literature.

Objectives. To describe clinical use of mesotherapy.

Methods. A cross-sectional questionnaire containing 30 questions regarding experience, indications, products and complications was distributed internationally among a convenience sample of equine veterinarians, using social media and authors' networks.

Results. Eighty practitioners (46/80 (57.5%) with >10 years, 15/80 (18.7%) 5-10 years and 19/80 (23.8%) <5 years' experience) completed the questionnaire. Most common indications were muscle stiffness in the thoracolumbar (60/80; 75%) and cervical (48/80; 60%) area, impingement of dorsal spinous processes (45/80; 56.2%) and osteoartrosis of cervical (33/80; 41.2%) and thoracolumbar (39/80; 48.8%) articular process joints. Respondents stated that they used mesotherapy as a complementary or primary treatment depending on individual case characteristics (31/80; 38.8%) or only as a complementary treatment (30/80; 37.5%), and less often only as a primary treatment (6/80; 7.5%). Most reported medications were lidocaine (46/62; 74.2%), dexamethasone (42/62; 67.7%), traumeel (33/62; 53.2%), saline (29/62; 46.8%), and sarapin (23/62; 37.1%). Total volume per treatment site varied from 20-60mL. Complications were reported occasionally (32/76; 42.1%) and included discoloration of hairs (13/76; 17.1%), skin hypersensitivity (12/76; 15.8%), worsening of symptoms (3/76; 4.0%), infection (3/76; 4.0%) and scarring (1/76; 1.3%).

Limitations. Not all participants answered all the questions.

Conclusion. Based on this study, the most common indication for mesotherapy is thoracolumbar muscle stiffness. A wide variety of medications is used; occasional complications mainly include discoloration of hairs and skin hypersensitivity.

Conflict of interest: None.

Ethical committee: Not applicable.

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