6th VEPRA – 1st ECVSMR Conference

EUROPEAN COLLEGE
OF VETERINARY SPORTS MEDICINE
AND REHABILITATION

19-21 SEPTEMBER 2019
GHENT - BELGIUM

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Publisher:

Przychodnia Weterynaryjna KANVET
Armii Krajowej 3 /160
10-072 Olsztyn

ISBN: 978-83-933750-2-8

Preface

Dear delegates,

We are privileged to welcome you in Ghent for the first combined conference of the Veterinary European Physical Therapy and Rehabilitation Association (VEPRA) and the European College of Veterinary Sports Medicine and Rehabilitation (ECVSMR) on 20-21 September 2019, preceded by a day with an exciting range of pre-congress workshops.

We are proud that Prof. dr. Steyaert will present the state of the art lecture on human sports medicine, which undoubtedly will provide ample food for thought and stimulate fruitful discussion and new ideas. This year's edition will offer a dedicated programme focused on small animals and, as an upgrade to previous editions of the VEPRA Conference, a programme dedicted to the equine field as well. We strongly believe that the scientific programme with various themes and topics related to veterinary sports medicine and rehabilitation will offer excellent opportunities to meet experts, to present and discuss research, provide new ideas and new knowledge on how to improve the treatment and care of patients.

We hope that you will enjoy Ghent (one of the best hidden secrets of Europe according to 'The Lonely Planet') during your stay, and that you will have plenty of opportunities to make new friends and reconnect with old ones, for example during the opening reception in the historic castle of Ghent, or during the congress dinner in a beautiful setting along the river.

We would like to close this welcome with a round of thanks for everyone who has made this conference possible. First of all, we thank all speakers for the time and effort they took to share their thoughts and experiences with us. Zoran Vrbanac is to be commended for organising the abstract submission and reviewing procedure and for compiling the proceedings. We thank Oliver Harms for his help in managing the financial aspects. We truly appreciate the excellent practical support provided by a highly motivated group of students (VSGk & VSGp) from the faculty of Veterinary Medicine of Ghent University. We thank the faculty of Veterinary Medicine of Ghent University for hosting the pre-congress workshops. Finally, we would like to thank all the sponsoring organisations for their generous financial support.

If you have any questions or comments, do not hesitate to get in touch with us!

Kind regards,

Yves Samoy, DVM, PhD, Dipl. ECVSMR

Vice-secretary ECVSMR

Chair of the organizing committee (Small Animal Programme)

Maarten Oosterlinck, DVM, PhD, Dipl. ECVSMR, Dipl. ECVS

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Small Animal Program

FRIDAY 20th

Sports Medicine Diagnostics and Training

8.15 – 8.45	Registration
8.45 – 9.00	Opening Ceremony
9.00 – 9.30	Ultrasound investigation of common shoulder and stifle pathologies in dogs. **Giuseppe Spinella** (IT)
9.30 – 10.00	Evolutions in kinematics and kinetics **Pia Gustås** (SE)
10.00 – 10.30	The Diagnosis of Lumbrosacral disease. **Noel Fitzpatrick** (UK)
10.30 – 11.00	Coffee break
11.00 – 11.30	Treatment of the clinical symptoms caused by osteoarthritis using nuclear magnetic resonance. **Marion Mucha** (AT)
11.30 – 12.00	Patellar Desmitis after cruciate surgery. **Philipp Winkels** (DE)
12.00 – 12.30	Lunchbreak
12.30 – 13.00	Lunchbreak – AGM VEPRA
13.00 – 14.00	State of the Art lecture: Sports Medicine in Humans **Prof. Dr. Adelheid Steyaert** (BE), UZ Ghent
14.00 – 14.30	Effect of leukocyte reduced platelet rich plasma in osteoarthritis caused by cranial cruciate ligament rupture: a canine gait analysis model. **Jose Vilar** (ES)
14.30 – 15.00	Treadmill exercise for assessment of functional capacity in canine athletes. **Zoran Vrbanac** (HR)
15.00 – 15.30	Coffee break
15.30 – 16.00	Nutrition in working dogs **Dominique Grandjean** (FR)
16.00 – 16.30	Canine athlete: sports training **Jana Gams** (SL)
16.30 – 17.00	The agility athlete: from surgery to super dog. **Ellen Martens** (BE)
17.00	End of day
19.30 – 22.30	Conference diner in “De Oude Vismijn”

SATURDAY 21st

Physiotherapy, Balance and Fitness

8.30 – 9.00	Welcome/Registration
9.00 – 9.30	The muscle build-up paradox **Philipp Winkels** (DE)
9.30 – 10.00	Home exercises: A new approach **Oliver Harms** (DE)
10.30 – 11.00	Physiotherapy: my approach in… **Ellen Martens** (BE)
11.00 – 11.30	Coffee break
11.30 – 12.00	Conservative treatment of shoulder lesions **Ludovica Dragone** (IT)
12.00 – 12.30	Sponsored lecture: Indiba Use of 448 khz radiofrequency in veterinary medicine. **Marc-Ignasi Corral-Baqués** (ES)
12.30 – 13.00	Lunchbreak – Poster session
13.30 – 14.00	Lunchbreak – ECVSMR AGM
14.00 – 14.30	Prehabilitation **Ilke Alaerts** (BE)
14.30 – 15.00	Sponsored lecture Vétoquinol Tolerance inducing therapies in chronic inflammatory diseases. **Femke Broere** (NL)
15.00 – 15.30	Physiotherapy as a possibility to increase quality of life in old dogs **Marion Mucha** (AT)
15.30 – 16.00	Coffee break
16.00 – 16.30	Balance and Fitness **Susanne Lauer** (DE)
16.30 – 17.30	Free Communications
17.30 – 18.00	Closing ceremony – end of conference

Equine Program

FRIDAY 20th

Sports Medicine Diagnostics and Training

8.15 – 8.45	Registration
8.45 – 9.00	Opening Ceremony
9.00 – 9.30	The Horse-saddle-rider interaction. **Annamaria Nagy** (UK)
9.30 – 10.00	Diagnosing cardiac and respiratory dysfunction in sport horses. **Mark Bowen** (UK)
10.00 – 10.30	Rehabilitation of equine herpes myelitis patients. **Marianne Sloet** (NL)
10.30 – 11.00	Coffee break
11.00 – 11.30	The dilemma of medicating the equine athlete. **Marianne Sloet** (NL)
11.30 – 12.00	Facts and fiction about diffusion after diagnostic analgesia. **Annamaria Nagy** (UK)
12.00 – 12.30	Lunchbreak
12.30 – 13.00	Lunchbreak – AGM VEPRA
13.00 – 14.00	State of the Art lecture: Sports Medicine in Humans **Prof. Dr. Adelheid Steyaert** (BE), UZ Ghent
14.00 – 14.30	Neuromuscular stimulation in the horse. **Anna Bergh** (SE)
14.30 – 15.00	Biomechanic differences between treadmill and over-ground locomotion **Michael Weishaupt** (CH)
15.00 – 15.30	Coffee break
15.30 – 16.00	Diagnosing cervical pathology in sport horses. **Jean-Marie Denoix** (FR)
16.00 – 16.30	Exercise testing and monitoring training progress warmblood sport horses. **Carolien Munsters** (NL)
16.30 – 17.00	The what and how of imaging findings without clinical significance. **Jean-Marie Denoix** (FR)
17.00	End of day
19.30 – 22.30	Conference diner in "De Oude Vismijn"

SATURDAY 21st

Physiotherapy and Rehabilitation

8.30 – 9.00	Welcome/Registration
9.00 – 9.30	Spinal biomechanics and muscle activity during equine locomotion. **Theresia Licka** (AT)
9.30 – 10.00	Videographic and kinetic techniques in horses under field conditions. **Jose Vilar** (ES)
10.30 – 11.00	Shockwave treatment of sacroiliac problems. **Aziz Tnibar** (MA)
11.00 – 11.30	Coffee break
11.30 – 12.00	Back pain - an international perspective. **Barbara Riccio**, (IT)
12.00 – 12.30	Breed differences affecting function and performance. **Willem Back** (NL)
12.30 – 13.00	Lunchbreak – Poster session
13.30 – 14.00	Lunchbreak – ECVSMR AGM
14.00 – 14.30	Feeding equine athletes. **Mark Bowen** (UK)
14.30 – 15.00	Injuries and rehabilitation of Standardbred trotters. **Andrea Bertuglia** (IT)
15.00 – 15.30	Injuries and rehabilitation of endurance horses. **Annamaria Nagy** (UK)
15.30 – 16.00	Coffee break
16.00 – 16.30	Injuries and rehabilitation of Warmblood sport horses. **Ana Boado** (ES)
16.30 – 17.30	Free Communications
17.30 – 18.00	Closing ceremony – end of conference

Proceedings Small Animal Program

(printed in chronological order of the presenting speakers)

These proceedings faithfully reproduce all abstracts provided by the authors, who are responsible for the content of their work.

ULTRASOUND INVESTIGATION OF COMMON SHOULDER AND STIFLE PATHOLOGIES IN DOGS

Spinella G.

Introduction

Use of ultrasonography (US) for musculoskeletal disorders is increasingly popular in small animal practice, due to its intrinsic features (low cost, ease of repetition, non-invasive procedure and possibility to perform it in conscious patients) and constant improvements of technology. Shoulder and stifle are currently the most investigated joints in dogs. This increasing interested in US has also partially changed the orthopaedist approach to these two joints, especially for diagnosing of no-mineralized supraspinatus tendinopathy and meniscal lesions, causes respectively of unsuccessful approach to bicipital tendinopathy and cranial cruciate ligament rupture (CCLR), if not correctly diagnosed.

Shoulder

The most commonly examined regions of the canine shoulder are the supraspinatus, infraspinatus and biceps muscles and tendons. The teres major and minor, deltoid and pectoral muscles are less frequently investigated. The biceps brachii tendon is characterized by parallel hyperechoic fibres (1,2). When a bicipital tendinopathy occurs, a thickened sheath and hypo-anechoic fluid surrounding an oval tendon are commonly seen in transverse scan. Different grades of bicipital tenosynovitis have been categorised (mild, moderate and severe) on the basis of the amount of fluid around the tendon and the homogeneity of the tendon structure (3). A synovial effusion creating a circumferential pattern around the tendon is also associated with lameness; however, a normal tendon with an increase in surrounding fluid secondary to medial shoulder instability or supraspinatus tendinopathy is often detected (1). The biceps tendon may also show tears, as focally enlarged and hyperechoic areas, or partial or complete rupture. In this last case, the tendon is no longer seen in the biceps groove, as it becomes distally retracted: the diagnosis is better carried out by dynamic US, enforcing movements of flexion/extension to shoulder and elbow joints.
Diagnosis of supraspinatus tendinopathy is exponentially increased in last decades by introducing US and/or MRI in orthopaedic diagnostic protocol. Previously, this diagnosis was limited to mineralized tendinopathy if shoulder was examined by x-ray. With US introducing, tendon alterations were visualized both in transverse and longitudinal scans: enlargement, modification of echogenicity (hyperchogenicity when fibrosis occurs), presence of mineralized areas often followed by acoustic distal shadow. Supraspinatus tendinopathy is generally diagnosed in sports dogs (agility, flyball, frisbee dog, hunting), because this tendon is highly stimulated during particular movement such as jumping or slalom (2).
Infraspinatus muscle could be involved by fibrotic myopathy (FM) (also known as infraspinatus contracture) highly expressed in hunting dogs (such as Breton). FM is often diagnosed during the

chronic phase, that occurs within 3-4 weeks after the acute phase. Acute phase is often misinterpreted by the owner as a temporary moderate lameness. FM is clinically characterized by a pathognomonic movement of involved forelimb: shoulder abduction, elbow adduction and extrarotation of antibrachium with a particular flip-like action. US examination during FM shows the muscle involved by diffuse hyper-echogenicity: sometimes the presence of inhomogeneous anechoic areas occurs in advanced phase, particularly close to muscle-tendon junction, probably related to areas of necrosis or inflammatory liquid.

Stifle

Ultrasonography of stifle is highly useful for assessing cartilage abnormalities, meniscal tears, muscle, tendon and ligament abnormalities, arthropathies, and neoplasia. Diagnosis of CCL rupture can be made by demonstration of the fluttering edges of the ruptured ligament; however, the possibility to diagnose CCL rupture by US is highly limited by impossibility to investigate the entire ligament within the joint. A recent ex-vivo study performed by Van der Vekens et al. (2019) has observed that a median percentage of 50% (range 30-60%) of total length of CCL (based on CT) could be visualized if high-frequency US probe was used for examination. The same study also resulted in observing heterogenous aspects in “normal” canine menisci and presence of fibrillary pattern in the cranial menisco-tibial ligaments and in the distal portion of CCL (4).

In 2013 Arnault et al confirmed the excellent visualization by US of superficial tendons (quadriceps and long digital extensor) and ligaments (patellar and collateral ligaments) of the stifle. The authors also reported a low US sensitivity of 15.4% for cranial cruciate ligament rupture and a high sensitivity and specificity for meniscal lesion diagnosis (positive and negative - 82%, 93%, 90% and 88%, respectively) (5).

In longitudinal scan through the cranial aspect of the knee, the patellar ligament is well and easily visualized as parallel hyperechoic lines from the patella to tibial tuberosity, mildly less echoic than other normal ligament (such as collateral ligament). Patellar ligament has recently received a high attention by ultrasonographers and orthopaedics because of its involvement when tibial osteotomy-based techniques (TPLO or TTA) are performed for CCLR correction. A constant enlargement of this ligament has been observed after TPLO and a larger cage size was associated with a more sever increase in radiographic proximal thickness and in ultrasonographic middle transverse area (6). Conversely, when TTA was performed, only the fifty percent of the cases showed a ligament thickening, but no statistically significant variables were identified as predictive of ligament enlargement. A more recent study performed by DeSandre Robinson et al. has reported patellar ligament thickening both for TPLO (97%) and TTA (92%) at first examination after surgery, however this percentage decrease to 77% for TTA at second examination (7).

Proximal tendon of long digital extensor is also well visualized from its origin just cranio-laterally to patellar ligament. Moderate/severe increase of intraarticular liquid amount is often recognized with an increase of liquid within the tendon sheath, because of tendon intraarticular crossing. Similar features are visualized in proximity of quadriceps tendon insertion on the patella.

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EVOLUTIONS IN KINEMATICS AND KINETICS

Pia Gustås

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Movement analysis is an important part of the clinical assessment. In any patient with neuromuskuloskeletal conditions, it belongs to the first steps in diagnostics as well as in follow-up evalutations and re-evaluations. Movement analysis is therefore routinely performed in the clinic and repeatedly recurring in each patient. The subjective nature of visual assessment in combination with the complexity of animal movements have caused a demand for measures to objectively describe and document movement pattern, but also to improve the analysis and assessment of the mechanisms behind locomotion and further, how we can interfere with it in different interventions. This has caused an evolution of kinematic and kinetic methods following the advancements in technology since the 19th century.

Kinematics is the study of movement of a body. The basics of Kinematics is all about measuring locomotion. The development of cameras enabled that, from one picture to another, measure movement. In the late 19th century, Marey in 1872 and Muybridge in 1872 used systems of cameras. Another big step that gave new prerequisites to studies of locomotion was computers. Already in the early 70's, SLU in Uppsala started kinematic research on horses. The researchers used the same technology as in the development of airplanes, where cinematographic high-speed movies where tracked with the help of a computer. It was time consuming with a large extent of manual work. In the early 90's, kinematic research on dogs was launched in veterinary medicine. Digital high-speed infrared light emitting video capture systems, together with advancements in computer software technology, allowed automated processing of large volumes of kinematic data.

Kinetics is the study of forces interacting with the body. The measurement of ground reaction forces with force plates are extensively reported since the 80's on normal locomotion, locomotion with concurrent orthopedic conditions, locomotion following surgical or rehabilitation interventions and on development of methods for acquisition. Budsberg, Verstraete, and Soutas-Little in 1987 reported on a developed methodology, using a single force plate, for the study of over ground walking of healthy dogs. Vertical, craniocaudal, and mediolateral forces were measured. Impulse, braking, propulsion and peak forces were further analyzed, considering relationships with morphometric measurements.

This study and many following, by the same authors as well as others, report on the effect of methodological differences interfering with force plates. Other factors that were investigated was the effect of subject velocity and acceleration, morphometric aspects, the handler, individual dogs and kinetics of different orthopedic conditions, before and after stabilization and of cranial cruciate ligament injury. A serial force plate system was presented by Bertram et al in 1997, which made it possible to simultaneously measure the impulse applied by each limb. In 2007, Bockstahler reported reliability when using four force plates attached to a treadmill, observing the walk of healthy dogs. Portable walkways based on pressure sensitive elements is another type of device for kinetic measures which have gained in popularity during the last decade (Lascelles et al, 2006).

Kinematic gait analysis of the trot was reported by DeCamp et al in 1993, using a four-camera system based on digital video technique. Temporal and distance variables, such as dog velocity, stride length, stride frequency and stance phase duration were reported to control the consistency of the dogs gait. Displacement data were captured from skin-mounted reflective markers, positioned on anatomical landmarks as bony prominences, end points of bone segments and skin surface positons representing the center of rotation for joints. Complex, dynamic events such as flexion and extension movement patterns was studied on Greyhounds, later also for mixed-breed dogs at the trot and the walk.

The early studies were followed by similar setups on the kinematics of gait in dogs with hip dysplasia and cranial cruciate ligament rupture. Other studies continued the development of methodology, the refinement of techniques as well as increasing knowledge on canine locomotion. Most of these are motion captured in a 3D calibrated space using a linear link model of the respective limbs to define motions in a 2D (sagittal or near sagittal) plane. Fu et al in 2010 presented an evaluation of a 3D kinematic model for canine gait analysis.

Using the treadmill in gait analysis has several advantages. It allows recording of kinematic, and if instrumented, also kinetic data in consecutive strides at a constant speed. It is efficient compared to over ground walkways. Biomechanically, there are however, differences between locomotion on a treadmill compared to over ground analysis. Several studies have used the treadmill for gait analysis purposes in healthy dogs, as well as in dogs with orthopedic conditions. The habituation of dogs to treadmill locomotion was investigated by kinetic measures by Fanchon et al in 2011, dogs at the walk by Bockstahler in 2007, and by kinematic measures at the walk and trot by Gustås et al. in 2016 and 2013.

Inverse dynamics analysis combines kinematic measures with force plate technique. Together with morphologic data (mass, center of mass, and mass moment of inertia) of the limb segments, Colborne et al in 2005 presented information on the net moments around the limb joints and patterns of muscle work, as well as joint power, in Labrador retrievers and Greyhounds. This technique have continued to develop for future usage.

During the past four decades, the methodologies of kinematic and kinetic gait analysis have been extensively used in small animal clinical research. The different gait analysis have been continuously developed following technology advancements to be more accessible for clinical studies. Studies on outcomes of different rehabilitation, surgery and other interventions, are now published more than ever on a greater extent.

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MY APPROACH TO DIAGNOSIS AND INDICATIONS FOR TREATMENT OF LUMBOSACRAL DISEASE

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RCVS Specialist in Small Animal Surgery (Orthopaedics), Diplomate American & European Colleges of Veterinary Sports Medicine and Rehabilitation, Director Fitzpatrick Referrals, FitzBionics and FitzRegen & Professor of Orthopaedics, Veterinary School, University of Surrey, UK.

Degenerative lumbosacral stenosis (DLSS) or lumbosacral disease is the most common cause of compression of the cauda equina and seventh lumbar (L7) nerve roots in dogs. DLSS is characterised by lumbosacral (LS) intervertebral disc (IVD) protrusion, subluxation or inflammation of the facet joints with associated thickening of the joint capsule and hypertrophy of the interarcuate ligament. The lumbosacral joint is the most mobile functional spinal unit (FSU) in dogs. Pathological static or dynamic alteration in load transmission across the L7-S1 joint is thought to be the most common contributor to lumbosacral intervertebral disc degeneration in dogs. A common sequel to disc-associated DLSS is impingement of the nerve roots or vasculature of the cauda equina and/or L7 nerve roots, either by the disc itself or by secondary inflammatory, fibrous or osseous impingement. Abaxial disc protrusion and spondylosis can be a significant cause of pain and lameness in large breed dogs whilst lower motor neurone deficits are much less common in our case population in the UK.

Key clinical features are associated with pain, including unwillingness to jump, go up stairs or take part in exercise, a hunched stance and uni- or bi-lateral pelvic limb lameness, which may occur after prolonged recumbency and may lessen or worsen with exercise. Pain originates from the degenerative facet and disc, the paraspinal musculature and direct impingement and stretching of the L7 nerve root itself. The sciatic nerve pathway can be digitally probed in the recess between the L7 vertebra and the ilium, in the recess of the caudal thigh musculature, or per rectum in the lesser ischiatic notch. Application of deep digital pressure in any of these areas may produce resentment and vocalisation. However, interpretation of these pressure tests is subjective and experience in normal and diseased dogs is important. Focal pressure application to the dorsal aspect of the lumbo-sacral junction is also a subjective pain-test and hyperextension of the lumbo-sacral junction in isolation without caudal extension of the coxofemoral joints is a useful interrogation during clinical examination. Objective measures of lumbosacral function and pain using kinematics and electrophysiology are evolving and may yield greater accuracy with regard to detection of clinically relevant pain. It is critical to exclude coxofemoral and stifle disease as well as other causes of pelvic limb pain and lameness. Though less common, infections and neoplastic pathologies must always be considered.

Diagnosis is generally based on clinical examination and advanced imaging. Neutral position and dynamic radiography has been evaluated in the diagnosis of LS disease. We have recently demonstrated that a flexed ventro-dorsal radiographic projection of the lumbosacral spine is sensitive for detection of abaxial spondylosis which is a significant contributor to clinical signs associated with L7 nerve root compression. However, the author never undertakes surgery in cases affected by DLSS without advanced imaging. The effect of intervertebral disc protrusion, spondylosis and facet inflammation on the cauda equina and L7 nerve roots cannot be determined without cross-sectional imaging.

MRI has superior soft tissue contrast resolution and sensitivity for detection of IVD degeneration is high. However, MRI lacks the ability to provide a reliable correlation between severity of clinical signs and the severity of the compression. Patients differ considerably in their ability to tolerate nerve compression and stretching associated with DLSS. CT is more valuable for assessment of definitive osseous boundaries, but good agreement between MRI and CT findings has been documented. MRI is frequently used in canine and human patients to identify primary lumbar foramenal stenosis, and unrecognised or recurrent foramenal stenosis may be associated with 'failed back surgery syndrome'. L7-S1 foramenal stenosis and associated compressive radiculopathy has been documented to occur with a reported incidence of 68-90% in dogs presenting with clinical signs associated with DLSS. Dynamic imaging may identify an even greater proportion of cases related to compressive radiculopathy.

MRI interrogation of the LS spine in dogs has been used to divide the L7-S1 intervertebral foramen (IVF) into entrance, middle and exit zones, allowing description of a foramen as stenotic when loss of the fat signal is complete or when only a minimal rim of fat signal is visible within one of the foramenal zones on parasagittal imaging plane sequences. Acquisition of MRI images in conventional parasagittal planes may fail to accurately represent the actual dimensions of the entry, middle and exit zones of the neuroforamena. We have performed both a cadaveric and an in-vivo comparison of standard parasagittal plane image acquisition with parasagittal oblique imaging where images are obtained perpendicular to the L7 nerve pathway rather than parallel to the sagittal plane. These studies have revealed greater sensitivity of oblique parasagittal imaging for detection of encroachment of the L7 nerve pathway in all zones.

We have also compared MRI scan acquisition in hyper-extended versus neutral positioning of the LS spine in sagittal and transverse planes and documented greater compression of the L7-S1 neuroforaminae in dogs with dynamic lesions. These are often working or agility dogs who may not manifest significant spondylosis and the diagnosis may not be detectable on neutral positional imaging. Intermittent claudication compression of the nerve roots may occur when the dog tries to jump or otherwise twist or extend the LS junction.

Regarding treatment, in dogs affected by DLSS, when oral medication, epidural steroid administration, acupuncture or physiotherapy modalities prove ineffective in relieving pain and disability such that quality of life is significantly impaired, surgical intervention may be indicated. Dorsal laminectomy and facetectomy with or without partial discectomy results in increased motion. Foramenotomy may not produce durable neuroforamenal decompression. Pins or screws and cement, or plates and screws, applied dorsally in mild flexion, can be effective in alleviating pain. Pedicle-screw-rod systems have been shown to be effective in restoring stability of the LS junction but traditional mono-axial screws lack versatility. Instrumentation with a recently developed novel spinal system has been shown to result in statistically significant enlargement of neuroforaminal dimensions and reductions in lumbosacral instability in extension, flexion and lateral bending concomitant with clinical improvement.

It is clear that more objective tests to define clinical severity of DLSS need to be developed based on functional questionnaires, electrodiagnostics, kinetic and kinematic profiles and similarly more objective outcome measures are needed following intervention. There are very different sub-groups of clinical cases varying from chronic osseous, discogenic and inflammatory impingement which may be adequately tolerated by sedentary dogs through to mild dynamic impingement poorly tolerated by very athletic dogs.

Randomised comparative trials would require large treatment cohorts to provide adequate power to discern between treatment differences and until clinical and imaging inclusion/exclusion criteria are established, this will be challenging. Furthermore, it is difficult to conduct unbiased randomised comparative trials with client-owned dogs. Therefore, it behoves all of us to focus on defining more rigorous definitions for diagnostic criteria, develop better understanding of the correlation between clinical signs and imaging findings, pay careful attention to clinical audit of all surgical interventions, and be as critical and transparent as possible in outcomes analysis.

MULTI BIOSIGNAL THERAPY (MBST®) FOR THE TREATMENT OF ARTHROSIS-RELATED LAMENESS

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A new method that is increasingly being used in veterinary medicine is the so-called magnetic resonance therapy, which is known under the trade name MBST® (Molecular Biophysical Stimulation) and was derived from diagnostic magnetic resonance imaging (MRI). The "Multi Biosignal Therapy" (MBST®) is based on the physical principle of nuclear magnetic resonance using weaker fields and lower frequencies than in imaging diagnostics. The effects should range from stimulation of the regenerative capacity and new formation of cartilage cells to reduction of pain caused by arthrosis and improvement of joint function.

Studies on the treatment with MBST®, however, yield partly contradictory results: while on the one hand in vitro positive effects with regard to the new formation and regeneration of cartilage cells (1,2) were shown, no effect could be demonstrated in an animal model study (3). In the clinical field, MBST® was investigated in various human diseases. For example, in patients with back pain (4) after daily therapy over five days, in addition to a standardized physiotherapy program, a significant improvement in pain in the MBST® group after three months could be described. In a multicenter study (5) involving more than 4,500 patients with osteoarthrosis and back pain, pain reduction was demonstrated six weeks after therapy, which was still detectable six and twelve months later. A study on the efficacy of finger function, in patients suffering from osteoarthritis in this region, showed a significant improvement nine days after therapy and six months later compared to a placebo group (6).

The partly positive reports on this therapy modality known from human medicine gave rise to the initiation of a randomised double-blinded study with dogs suffering from osteoarthritis. The aim of this study was to test if MBST® can improve lameness.

A total of 30 dogs were included in the study. Participation criteria were the presence of radiologically evident arthrosis as well as clinical signs such as pain and/or lameness in the orthopaedic examination. The dogs were randomly divided into two groups, with 15 dogs receiving placebo treatment and 15 dogs receiving actual therapy, with neither the investigating veterinarian nor the owner knowing which dog received which therapy. For ethical reasons, the animals were allowed to receive pain medication and, if necessary, supportive physical therapy during the study.

The treatment (or placebo treatment) was performed on nine consecutive days and lasted one hour each. The dogs were placed within the coil area and were allowed to move slightly as long as the target joint remained within the coil area for the full hour.

On days 0 and 9, three and six months after the last therapy the dogs were orthopaedically examined and the degree of lameness and severity of pain in the affected joint were recorded on a 5-point scale. For the objective evaluation of lameness, ground reaction forces were measured using a pressure mat. The maximum vertical force (PFz) and the vertical impulse (IFz) were used for evaluation. These values of the affected and the contralateral extremity were related to each other and a symmetry index, as an expression of the lameness in percent, was calculated.

Lameness and pain were significantly reduced in the therapy group after three months compared to the measurement at the beginning of therapy, but this significant change was no longer detectable after six months. The results of the ground reaction force measurements showed a significant improvement of the symmetry indices for PFz and IFz in the therapy group after three months. After six months these values deteriorated again, but did not reach the level of the baseline values, although statistically no significance could be demonstrated. In the placebo group, no significant changes were observed at any time (7).

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PATELLAR TENDINOPATHY AFTER TPLO – IMPLICATIONS FOR REHABILITATION

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Inflammation of the patellar ligament has been reported after the tibial plateau leveling osteotomy (TPLO). Inflammation of the patellar ligament can range from asymptomatic ligament thickening, an incidental finding on postoperative radiographs, to clinical desmitis. Findings on radiographs in dogs with desmitis include soft tissue swelling, thickening at the level of the tuberosity, and irregular ligament margins. Findings on ultrasound in dogs with desmitis include thickening, disruption of fiber orientation, hypoechoic or anechoic core lesions, and increased echogenicity of peri-ligamentous tissues. Clinical desmitis includes these radiographic and ultrasound findings as well as pain on palpation and lameness with activity. The cause of these ligament changes is unknown but some proposed mechanisms include increased ligament strain or load, intraoperative trauma to the ligament, vascular damage during the surgical procedure, excessive postoperative activity, or alterations in stifle biomechanics. Carey et al (1) identified a cranial osteotomy, partial cranial cruciate ligament tear, and tibial tuberosity fracture as risk factors for patellar ligament inflammation. Nevertheless, a study in order to identify the most important cause or causes is missing. Patellar ligament inflammation appears self-limiting but severe cases can cause marked lameness and prolonged recovery from TPLO. It seems that lameness 6 or 12 weeks after TPLO is generally accepted during rechecks. Missing or wrong treatment may lead to a shortened patellar ligament and a patella baja. Furthermore, effective treatment could reduce the time of recovery.

Different theoretical treatment options are available, but only few evidence is present.

Treatment Options

Shock wave

Shock wave therapy has been shown in a prospective, randomized, controlled clinical trial that the radiographic signs of patellar ligament desmitis can be decreased in dogs receiving a TPLO with natural cranial cruciate ligament disease.(2) The working mechanism has been evaluated in several studies. The process of ligament repair includes angiogenesis, inflammation, fibrogenesis, and remodeling, which is amplified by shock wave therapy.

Laser

In human medicine laser therapy seems to be most effective in acute tendinitis. In veterinary medicine laser has been used in canine stifles. The objective of this study was to determine the influence of a laser protocol on the clinical outcomes of dogs treated with TPLO. The patellar tendon was not evaluated, but the healing of the osteotomy. This study provides some evidence, that low-level laser therapy may improve the gait of dogs recovering from a TPLO, as assessed by owners. Nevertheless, the reason for the clinical improvement was not identified. Healing of the osteotomy was not different between treatment and placebo group. One reason for improvement could be the incidental treatment of the patellar tendon, which was not analyzed. Studies should be performed for further evaluation.

Gait modification

No studies are available about gait modification. In human medicine gait modification is one of the major therapeutic approaches used for tendon/ligament treatment, like Achilles tendinopathy or tennis elbow. Especially eccentric training has the biggest evidence for its effectiveness. In addition it is important to avoid the trauma/overuse of the diseased structures. After TPLO in dogs gait restriction is recommended, but often not explained in detail how to perform and the relevance. Furthermore, compliance varies a lot between the owner and cannot be controlled. Tools like activity tracker could be used.

Thermal therapy

Cryotherapy immediately has been recommended and might be beneficial in order to reduce the inflammation. Later during the healing process or in chronic conditions heat could be beneficial to increase the blood circulation.

Regenerative Medicine

Platelet injections

In human medicine (3) it has been shown, that injection therapy of PRP is effective for the treatment of patellar tendinopathy and has the promising potential to restore patients to their activities of daily living, work, and sports. However, through the present research, it is hard to draw a clear conclusion for the effectiveness of PRP treatment on patellar tendinopathy.

Summary

Studies are highly needed in order to identify exactly the cause and standard protocols need to be established and evaluated for effective treatment of patellar ligament desmitis. Until then, treatment of the patellar tendon is recommended with available rehabilitation options with the best evidence we have.

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EFFECT OF LEUKOCYTE REDUCED PLATELET RICH PLASMA IN OSTEOARTHRITIS CAUSED BY CRANIAL CRUCIATE LIGAMENT RUPTURE: A CANINE GAIT ANALYSIS MODEL.

The following content is based on the own author research and some results were previously published as: Vilar JM, Manera ME, Santana A, Spinella G, Rodriguez O, Rubio M, et al. (2018) Effect of leukocyte-reduced platelet-rich plasma on osteoarthritis caused by cranial cruciate ligament rupture: A canine gait analysis model. PLoS ONE 13(3): e0194752. https://doi.org/10.1371/journal.pone.0194752.

The aim of this keynote was to evaluate the effect of a platelet-rich plasma (PRP) obtained with standard procedures in English bulldogs with stifle osteoarthritis (OA) due to cranial cruciate ligament rupture (CCLR) non surgically treated.

In order to obtain objective data, a force platform and electrogoniometric gait measurements were used. The recorded data were the peak vertical force (PVF), vertical impulse (VI), stance time (ST), and angular range of motion (AROM).

Data were obtained from 12 lame, CCLR English bulldogs and 10 sound dogs of the same breed used as negative control group.

PRP was injected into the joints of dogs corresponding with the study group on days D0, D7, D14 and D21.

Biomechanical data were recorded at Day D0, D30, D90 and D180 after the first administration of PRP.

Statistical analysis of data was performed using a linear mixed effects model.

Mean values of PVF, VI, ST, and AROM increased within the first 90 days; however, values almost returned to the initial state after 6 months.

As conclusion, dogs with CCLR treated with intra-articular PRP improve PVF, VI, ST, and AROM over time, although the duration of effect is temporary.

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TREADMILL EXERCISE FOR ASSESSMENT OF FUNCTIONAL CAPACITY IN CANINE ATHLETES

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There are different methods to determine or monitor functional capacity in order to plan a suitable exercise programme. General factors of functional capacity are oxygen consumption (VO2) and heart rate (HR). Heart rate is considered a useful indicator of relative cardiovascular load, and therefore may be used as an indicator of exercise intensity (1).

Parameters commonly used for evaluating the aerobic capacity are the maximum oxygen uptake ($VO2_{max}$) and anaerobic (lactate) threshold. Lactate concentrations in blood increase during physical exercise of certain intensity and can be measured using two different methods: in a laboratory using the standard biochemical analysers and by hand-held portable lactate analysers. The main advantage of portable lactate analysers is simple handling and immediate results.

$VO2_{max}$ is used to determine an individual's maximal aerobic power and is an important predictor of endurance exercise performance. Since the VO2 maximum is proportional to the increase of HR during exercise, and increased $VO2_{max}$ is a sign of overall aerobic metabolic rate, prolonged exercise will cause increase in $VO2_{max}$. By monitoring the HR frequency, conclusions may be inferred regarding changes in aerobic capacity.

Variations in HR during activity correlate with changes of exercise intensity and may be recorded directly by radio-telemetry in dogs. By recording the heart rate during a training session or exercise, the relative heart rate to the intensity of the work load (% maximum heart rate) can be calculated. Determining the maximal heart rate (HR_{max}) is necessary for establishing a percentage of HR to HR_{max} that defines the exercise intensity.

In dogs, different studies have reported differing HR_{max} : 300 BPM in a mixed breed group (2), and 318 BPM in racing Greyhounds (3). During agility competition a HR_{max} of 220 BPM was reported in dogs (1), but was 246 BPM during an incremental test in agility Border collies (4). It is generally accepted that a value of 300 BPM is a HR_{max} for dogs, but this is dependent on breed, exercise intensity and fitness status.

Conconi et al. (5) developed a simple test and a method to determine the heart rate deflection point (HRdp). This non-invasive method is considered a reliable predictor of aerobic performance by many, concurrent with lactate threshold. HRdp is characterized by a distinctive differentiation or 'deflection' in the linear HR-work relationship or heart rate performance curve exhibited during progressive incremental exercise testing. This is visually manifested as a curvilinear response and is reported in the range of 88 to 94% of maximum HR for athletes in various sports and under different protocols. The use of HRdp in sport dogs was first described in a study on agility Border Collies (4), and recently also in sedentary Beagles (6) and detection dogs (7).

In a study of agility dogs, fourteen healthy Border Collies aged 3.9 (± 2.3) years were submitted to incremental treadmill exercise. Heart rates were recorded using Polar System fixated around their chest. Each subject started the protocol by walking at a speed of 5 km/h in order to warm up. After warming up the treadmill speed was gradually increased every 30 seconds for 0.5 km/h. The slope was adjusted to 5% for all dogs.

Heart rate deflection point (HRdp) and the speed at deflection point (Vdp) were determined using two methods: independent visual inspection and computer-aided regression analysis within Polar PRO trainer software. After the completion of each dog's running session, the HR/speed relationship was graphically displayed. The HRdp and Vdp were identified as the point at which the values of the slope of the linear portion of the speed/HR relationship began to decline and the values of the intercept on the y-slope began to increase.

Average HRdp was 183 i.e. 184 BPM (depending on the method used), 80% of the maximum average heart rate achieved in this study which was 230 BPM. However, the range of individual HRdp was between 162 and 229, which indicates the need of individual approach to assess physiological parameters of each sport dog.

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NUTRITION OF WORKING DOGS

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NUTRITION AS A SOURCE OF PERFORMANCE

As humans and horses, intense work and competition cause a specific energy expenditure in dogs (quantity and quality), as well as a physiological and psychological stress. This is especially emphasized on racing sled dogs, in relation with tough environmental conditions and with the fact that the type of races (ultra-marathon, long or mid-distance, sprint) has a great influence on the nutritional requirements. Nutritional adaptation is therefore necessary and must take into consideration quantitative and qualitative energy needs associated with muscular work, and also modifications in nutritional requirements based on the dog's build and stress level.

Generally speaking, food formulated for racing sled dogs should :

- provide an optimal quality of energy in adequate amounts
- minimize the volume and weight of the intestinal bolus as much as possible (highly digestible and highly concentrated food
- possibly have a buffer effect on the metabolic acidification than can occur in some racing conditions (dogs running over their anaerobic threshold in sprint or stage races)
- help maximize biological results of other ergogenic activities (training, etc…)
- fullfill physiological gaps created by oxidative cellular stress
- be a true preventive factor for effort related gastrointestinal problems
- help maintain the organism hydration at its best as possible

Apart of the purely nutritional design of the food, both palatability (for tired dogs) and practical distribution methods have to be taken into account, as well as ergogenic nutritional supplements dedicated for exercise have to be closely examined, regarding actual knowledges.

NUTRITION AS A SPECIFIC PREVENTION TOOL

Stamina is a challenge for the organism, and as an athlete, working dogs are subjected to pathologies related to physical exercise.

The first main pathologies met in working dogs concern the digestive tract. Acute and stress diarrheas are common, and chronic vomiting can appear due to stomachal excess of acidity. The effort diarrheas are profused, watery, sometimes bloody and can lead to dehydration especially if the dog is not drinking enough to compensate the loss of water induced by the diarrhea. They are mainly caused by stress (increased speed of digestive transit, « runner's trot »), can turn bloody due to mechanical microlesions induced by feces hurting the colon during a run (« caecal slap syndrom »), and involve the ischemia-reperfusion of the digestive tract during stamina. Indeed, during exercise, blood flow is mainly redistributed to the muscles and the cardio-vascular sytem, and decreased in the digestive tract. To fight the consequences of this temporary hypoxia, nutrients quality and feeding timetable are important prevention tools. A hyperdigestible food decrease the waste in the low digestive tract, and reduce feces quantity. The use of clays can enforce the protection of the digestive mucosa, and EPA/ DHA help coping with induced inflammations in the digestive tract. Specific sources of fibers, especially FOS and MOS, help to slow down the transit, and prevent pathogens microbial proliferation in the bowel. MOS also increase local immunity through specific effects. The last prevention practical method is to feed sensible dogs not too early before the exercise (minimum 2 hours before the exercise), and to refeed them with 2/3 of their daily intake less than two hours after the end of the exercise. Not feeding the dog just before the exercise is also important for limiting gastric disorders, especially vomishments (gastric volvulus too even if this prevention is not scientifically demonstrated). Those vomishments can cause severe bronchopneumoniaes impairing dog's life. The prevention of gastric ulcers is for the moments based on anti-acids treatment (omeprazole for example), as the physiopathogeny is still not fully understood. Chronic stress, inflammation, oxidative stress are partly involved but more investigations are needed to fully understand the development of those ulcers.

The second main group of pathologies concern the locomotor system. Contraction and decontraction muscle cycles, repeated movement on sometimes harsh floors, lead to muscle and joint fragility. Paws are challenged too by runs and jumps on difficult floors. A study on sled dogs showed that the quantity and quality of proteins affect the number of dogs dropped from a race for musculo-squeletal injuries. Branched-chain amino-acids (leucine, iso-leucine, valine) are commonly used to improve the muscle recovery during intense training periods. For the moment, proteins quality index do not exist that would allow veterinarians and users to compare the quality of proteins in commercial diets. Even if feces quantity and quality, and muscle development bring some informations, such an index may help to put the quality in front of the quantity of proteins put in a diet. To help joint maintenance, the use of GAGs bring some support to cartilage nutrition, and decrease the evolution of arthrosis if given early in the working dog life. Aside from the nutritional prevention, physical training, warming up and recovery are key points to maintain an healthy locomotor sytem.

Last main group of pathologies are metabolic deseases. Dehydration is the first risk for working dogs. Even 1% dehydration, which leads to no decrease in skin elasticity, or mucosa dryness, induce a decrease in performance and an increase in musculo-squeletic injuries or heat-stroke. Drinking enough is sometimes challenging for dogs, and the use of fatty acids to provide metabolic water is an interesting help. This dehydration risk is enhanced in hot climates. Heat stroke is the second main metabolic pathology in working dogs. It not only come from the environment, but is in relation to the ability of the dog to produce less heat during stamina. This improvment in the energy transformation yield can be obtained by a good training, probably genetic selection and the availibility of nutrients in the muscle at the time of the exercise.

NUTRITION AND TRAINING ARE CLOSELY CONNECTED

During stamina, an increased demand of energy is noted to allow ATP production in the muscle, and muscular contraction. Several metabolic processes are used successively to produce ATP : alactic anaerobiosis, lactic anaerobiosis, or aerobiosis. The first one utilizes the ATP reserves coming from the muscle itself, rebuilt quickly by the creatine-phosphate system, but can only help to sustain a few seconds of hight intensity exercise. The second one uses glycogen reserves fom the muscle and the liver, and leads to the production of ATP and lactic acid through the glycolysis process. Thanks to this system, hight intensity exercise can be sustained for a few minuts. The aerobic process is based on the oxidation of substrates (triglycerides for 80%, carbohydrates for 15%, and amino acids for 5%) and allows exercises lasting several hours, but with a moderate intensity. Regarding the dog physiology, suych an endurance stamina could last forever as long as the dog is fed and hydrated correctly (fat as THE source of energy).
During work, the dog is using the different metabolisms, and consume his reserves in relation with the metabolism stimulated. For example, a search and rescue dogs working in a rubble will have to work for 20 to 40 minutes, and jump to cross fragments. He will stimulate mainly his aerobic metabolism, and his anaerobic metabolism. For a tracking dogs, working on leash, the anaerobic metabolism will be less stimulated.
To improve perforemance, a dedicated physical training program is developed for each kind of dogs. The nutritional program will be adapted to provide the right nutrient at the right moment. Fopr exercises which stimulate the aerobic metabolism, having some fatty acids already usable by the muscle at the beginning of the exercise will help to help the metabolism, by sparing the mobilization time from the reserve sites to the muscle. Short and medium chains fatty acids, used in Energy booster supplement (Royal-Canin®), given one hour before or during the exercise, bring quickly an increase in fatty acids level in the blood and are quickly oxidised by the mitochondria because they don't require lipase for their absorption in the bowel, and don't require L-carnitine to enter in the mitochondria. After an intense exercise, leading to a decrease in carbohydrates reserves, the absorption of complex carbohydrates in the 30 minutes following the exercise help to replenish those reserve, and decrease the recovery time in dogs.

Aside from this increase energy demand, the mental, physical, and organic stress related to exercise, induce an increase demand in micronutrients. Aerobic process lead to a hight oxygen consumption (around 120 mL/kg/min), which increase the production of free radicals and an increase oxidative stress. The improvement of antioxidants, hydrophils and lipophiles perform in performance diets help to fight against this process. Polyphenols, vitamins (A, E, C) added in quantity help to catch free radicals, and prevent their actions on cells memebranes, organites membranes, and DNA. This increase in oxidative stress is coming with an increase inflamation related to the increase number of muscle contractions. This inflammation can not only cause muscle cells injury, but also modifie the immune system efficacity throught a modification of inflammation mediator circulation (cytokins, enzymes…). EPA and DHA are used to fight this inflammation.

The last challenge for working dog is the environment. Hot weather, humidity, altitude…all those factors can badly affect the working dog performance. During the training, it is possible to use the working dog to this challenging environment, by working him for progressively longer period in hard environmental condition. However, seach and rescue dog scan be thrown in chalenging environment in a few hours, and have to work in a meteo hugely different from their kennel. The food can help to sustain their stamina by providing them enough energy, and specific nutrients which help them to fight against dehydration, heat stroke, oxidative stress, and inflammation.

TRAINING	GOALS	NUTRITION
VO_2 max ↑↑ →	ENDURANCE	← Fueling : fat…
Lactates Tolerance →	RESISTANCE	← LDH : Zn ; Vitamins B…
Muscle Power →	STRENGHT	← Solid bones and tendons : Prot, Ca, P…
Anaerobic Lactic Power →	SPEED	← Fueling : glycogen, Vit B…
Movement balance →	PROPRIOCEPTION	← Quality of joints : gags, omega3, trace-elements…
Work as a game →	MOTIVATION	← Neuromediators : amino-acids
Red cell count ↑↑ →	OXYGEN TRANSPORT	← Sports anemia: proteins
Oxidative stress ↓↓ →	STRESS	← Antioxidant nutrients

»CANINE ATHLETE: SPORTS TRAINING«

by Jana Gams, DVM, CCRP student, CEO of Dogs4motion Canine Rehabilitation and Hydrotherapy Center, active competitor on international level in Agility and FCI Obedience

www.dogs4motion.com

There are more than 60 different dog sports out there for active owners with their dogs to participate at. Knowing the specifics of each dog sport our clients are involved with can majorly contribute to their experience with our services.

If you want to help your clients developing their canine athlete up to the top sports level, you have to know their sports disciplines in details. With this knowledge you will be able to put together a great strengthening plan, give good advices to help with preventing overuse of particular body parts or even risks for injuries, understand their goals, and build trust into you as a professional.

Some of the most popular dog sports in Europe:	
- Agility	- Obedience disciplines (FCI Obedience, Rally Obedience, …)
- Flyball	- IPO / Schutzhund
- Disc dog (Dogfrisbee)	- Search And Rescue
- Canicross/ Bikejöring	- Lure Coursing
- Dock Diving	- Tracking (Scent works, Mantrailing, …)
- Herding	

You can learn about each dog sport by reading through its competition rules and guidelines, by visiting the competitions, if possible even trainings, to learn what actions dogs have to perform, what kind of movements, what are the impacts / forces on dog's body. Knowing how many rounds each dog has on trainings and competitions (per day / per week), what environment are they training in, what strengths the dogs need to withstand the forces during performance, will help you to better understand also their condition needs.

Why is there such a high risk for injuries at sporting dogs?

- If not properly warmed up prior to activities, they will need to go from rest to full speed
- The dogs may start training before skeletally mature and develop problems because of this
- Repetitive and/or "unnatural" movements will cause overload of specific body parts
- They may not be given enough recovery or training time (because of budget, time or competition pressures)
- They might suffer repetitive injuries over their life span
- They will be expected to perform fully on return to work or sport

There are 4 basic elements of training:

- Endurance
- Power / Strength
- Speed
- Coordination & Flexibility

Each dog sport has different ratio of needs, depending whether the dog sport is more endurance-, or more sprint-like. For example with Canicross dog we should put emphasis on endurance and power skills, versus in the Flyball, where dogs should work mostly on speed and flexibility. Agility, IPO and Disc dogs need a good balance within all 4 elements.

Good physical preparation away from the sport enables good foundations for the specific skill trainings in the sport, just like in human sports.

The importance of WARM UP / COOL DOWN

Warm up and cool downs should be the alpha and omega of every dog training andcompetition. Warm up: not only it prepares the dog's muscles pumping and going, it also highly reduces the risk for potential injuries. Cool down helps with slowly bringing the heart rate down, and keeps good blood and lymphatic circulation through tissues for flushing away the metabolic waste.

How to design a good Warm up routine for your clients?

Think about the moves and actions the dog will have to perform within its activity. The goal of a good warm up is to take and include the actions similar to their expected activity, and prepare the muscles and connective tissues within low intensities first.

It should always consist of:

- At least 8-10 min walk / trot for toileting
- At least 5-10 min of a variety of different exercises according to the specific sport's needs. Progress from low intensity / slower tasks gradually to more and more active / explosive ones.

Cool down

Should consist of at least 15-20 min walk, ideally also stretching exercises to help the muscles elongate and relax.

> The five S's of sports training are: stamina, speed, strength, skill, and spirit; but the greatest of these is spirit. – Ken Doherty

THE AGILITY ATHLETE : FROM SURGERY TO SUPER DOG.

Ellen Martens, MPT, MT, CCRT

Summary

Rehabbing a patient to normal daily activity is one thing. Rehabbing an agility dog to maximum performance is another thing. Where the rehabilitation of the family dog stops, the rehabilitation of the agility dog still continues to get maximal strength, flexibility, ROM and at the end high end performance without compensation, and without recurrence of the clinical signs.

What are common injuries in agility dogs and how do we rehab these driven dogs? We have to find a balance in promoting weight bearing without overloading. Controlled activity during rehabilitation is a must, so what are safe exercises to start for early muscle activation? How does a treatment plan for an agility dog differs from the treatment plan for a family dog? What are our main rehab goals with these athletes? And how do we convince owners that after rehabilitation the retraining for sports is as much important?

Common injuries

In our rehabilitation center we see a lot of agility dogs with injuries. These injuries could be traumatic or chronic or even congenital.

The traumatic injury can happen during training, for example cruciate injury of the stifle or hyperextension injury of the spine, but can also happen during daily activity or because of an accident, for example hit by car or two dogs that ran into each other.

The chronic injuries that we see are often repetitive strain injuries, like we also see in humans, for example the tennis elbow, and osteo arthrosis. Repetitive strain injuries are caused by continuous overload on the muscle tendon system. These injuries don't happen in one training but are a result of overloading the body over a longer period of time. Osteo arthrosis and spondylosis are degenerative diseases that we see a lot in the middle-aged to older agility dogs. This could be the result of joint laxity or spine instability but also because of repetitive overload of the joints and the spine or because of too intensive exercise and training of the immature body. I think for example about starting too soon with intensive weave training or doing repetitive intensive sharp turns before the age of one year. In these dogs the active muscle stabilization system in the body is not developed well enough yet to help stabilize the excessive load on the joints and the spine. Because of that the joint capsule and the ligaments are overloaded in an attempt to stabilize the joint or the spine. An extra factor to consider is that in these young dogs the balance, coordination and proprioception is not optimal yet. This combined with a high speed and a lot of drive of the young dog results in a lot of uncontrolled movements. All this makes that the joints and spine are predisposed to develop early osteo arthrosis and spondylosis.

The genetic diseases that we see a lot in border collies that are bred to sport with are still hip dysplasia, medial coronoid disease, shoulder OCD, OCD of the tarsal joint and lumbosacral instability. Can these dogs do agility in the future? It depend on a lot of factors : severity of the clinical signs, the age of onset, the time between clinical signs, diagnostics and treatment, complications, owner compliance and the rehabilitation and training.

The most common pathologies that we see in agility dogs are: medial shoulder instability, supraspinatus and biceps brachialis tendinopathy, teres major strain, infraspinatus strain, flexor carpi ulnaris tendinopathy, OA in the carpi and the toes, strain of the ligaments of the toes, iliopsoas strain, cranial cruciate injuries, SI joint problems, superficial digital flexor luxation, pathology of the lumbosacral area with swelling and entrapment of the nerves, foraminal stenosis, …

Rehabilitation of the agility athlete

The rehabilitation process of the agility athlete has the same structure as the rehabilitation of the family dog : evaluation, problem list, assessment, treatment plan and reevaluation. When these sporting dogs come in after an injury, for example a cranial cruciate rupture with a standard TPLO surgery, we would still do a full evaluation to create this individual treatment plan. This could be the reason why two dogs with exactly the same injury and surgery could undergo a totally different rehabilitation process.

The biggest advantage of rehabbing the athlete is that they often come in with good muscle mass, muscle strength and active muscle stability so that they have a step ahead compared to the mean family dog. Because of this often the weight bearing status is sooner back to normal. Also the focus and drive of these dogs help with prescribing exercises, they are more likely to forget about the surgery and do a full weight bearing without compensation.

Although in some situations this could be a disadvantage too because the drive make them want to work so that they need to be protected to not overload the surgery leg.

We start really early with isometric cocontractions agonist/antagonist to start with early muscle activation. Depending on the injury and the dog we can progress these exercises pretty fast. A really important goal in these athletes, but also in every dog, is the neuromuscular control. This neuromuscular control is altered after injury so that they have more risk to recurrence of the clinical signs. Think about an inversion trauma of the ankle : the injury can be healed long time ago but we still have the feeling to collapse, especially in unexpected circumstances or on uneven surface. This is caused by the lack of neuromuscular control. The same thing happens in the athlete post injury. So prescribing specific exercises to target the neuromuscular system are a must.

THE MUSCLE BUILD-UP PARADOX

Philipp Winkels

A discussion...

HOME EXERCISES: A NEW APPROACH

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Home-based physical therapy (HBPT) is an common element of physical therapy rehabilitation programmes in small animals. Whether the exercises are really done by the owners, however, is questionable and difficult to check.

In human medicine there is up to 70% non-compliance.[1] Understanding factors that influence patients' adherence to HBPTs could help practitioners support better adherence. Essery et al have shown in human physiotherapy that there was relatively strong evidence that the following factors predicted adherence to HBPTs: intention to engage in the HBPT, self-motivation, self-efficacy, previous adherence to exercise-related behaviours and social support. Assessment of these domains before providing individuals with their HBPT regimes may allow identification of 'risk factors' for poor adherence. These can then potentially be addressed or managed prior to, or alongside, the therapy.[1]

Grossklaus et al demonstrated that physiotherapists may influence adherence predominantly during the motivation phase by using communicative, objective, relationship level and therapy variables. During the realisation phase the categories of home exercise programme and planning com to the fore regarding the influence on adherence.[2]

Lonsdale et al show that communication skills training for physiotherapists had positive effects on patient adherence. This training may provide a motivational basis for behavior change and could be a useful component in complex interventions to promote adherence. Communication skills training may also improve some clinical outcomes for women, but not for men.[3]

Apps are a simple way to give motivational help, monitor the exercises done and a low-threshold way to get feedback.

Lambert et al. indicated that people with musculoskeletal conditions adhere better to their home exercise programs when the programs are provided on an app with remote support compared to paper handouts.[4]

Benell et al came to simmilar resulsts: A web-based exercise programming system improved home exercise adherence and confidence in ability to undertake exercise.[5]

Especially adolescents viewed technology support such as text reminders as a potential solution.[5]

We have taken the results from human medicine as an opportunity to conduct a survey among animal owners, animal physiotherapists and veterinarians. The results can be compared with those of human medicine. The animal owners were also afraid of doing something wrong with the animals. The physiotherapists also wanted to have the opportunity to exchange ideas within the pyhsiotherapists and to be better integrated with the veterinarians.

We have translated these results into the development of an animal physio app to achieve the goal of improving compliance and thus hopefully also clinical outcomes.

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PHYSIOTHERAPY : MY APPROACH IN TREATING OA AND HD.

Ellen Martens, MPT, MT, CCRT

Summary

Orthopaedic and neurological conditions are the two major fields in animal rehabilitation. Many orthopaedic diseases and injuries benefit from physical therapy. The therapist plays a role in both the conservative and postoperative management of the orthopaedic patient.
After a thorough assessment we will design an individualized treatment plan. Because we individualize the rehab goals and plan of care it could be that two patients with the same orthopaedic condition receive a totally different rehabilitation. That's why there's no standard physical therapy treatment program for the different conditions or injuries.
Not every treatment technique is applicable in every stage of the rehab process. Also, not every orthopaedic condition benefits from hydrotherapy. Sometimes hydrotherapy is even contraindicated. In this lecture we will talk about the different assessment and treatment techniques, indications and contraindications, how to build a treatment plan and when to start treatment. We will go in detail into the physical therapy treatment of OA and HD, because not every dog with HD gets the same treatment, it depends on the veterinary treatment and on our evaluation.

Framework for rehabilitation

When a dog comes in to start a rehabilitation program we have to begin with a full evaluation. The evaluation gives us some clinical findings that we can prioritize in a problem list. This helps us to write an assessment and to design the treatment plan. Every treatment will be followed by an evaluation to see if we have to make changes in the treatment plan to meet the functional rehabilitation goals.

Physical therapy evaluation

A good treatment starts with a good evaluation. We start with collecting subjective data by asking specific questions about the clinical signs, pain, medication, mentation, home environment, diet, previous and current activity level, and last but not least about the client goals and expectations. It is our job as a therapist to guide the client in defining these goals so that the expectations are realistic.
After collecting the subjective data we want to know about the full medical history. We have to get information about the history of the present injury : what was the date of onset, what exacerbates it, what improves it, which diagnostics have been done so far, what are the prescribed medications, supplements and activity restriction. We have to make sure that we get all the information we need to reveal any rehabilitation restrictions/limitations.
After the subjective data we can go on to collect objective data. We start with taking a look at the posture, function, strength and gait. A full body scan gives us a first impression of heat, swelling, muscle tone and pain. We proceed the examination with active and passive range of motion, flexibility, palpation, joint play, special tests, clearing the spine and if necessary neurological evaluation.If we have all the data we need we can list the abnormal findings in a problem list and write an assessment. The assessment is the hypothesis that explains all of the

clinical findings on the problem list.

Designing a treatment plan

The treatment plan describes the short and long term treatment goals, the treatment techniques that will be used to meet the goals and the physical therapy prognosis. It also includes the frequency, intensity and duration of the treatment. Like said earlier it could be that the treatment plan has to be redesigned during the rehabilitation process.

Treatment techniques

The treatment techniques that we use in physical therapy are soft tissue mobilization and stretching, active and passive range of motion, joint mobilization and manual therapy, modalities and therapeutic exercise (including hydrotherapy and sportspecific training). As in human medicine we want to start rehabilitation as soon as possible. Not every treatment technique is applicable for every orthopaedic condition and in every stage of the rehab process. The knowledge of the therapist plays a cruciate role in choosing the correct technique for that condition in that stage, knowing the indications and contraindications for every chosen technique.

Another important role of the physical therapist is to give advice regarding activity restriction, home exercises, home environment, aides and return to normal daily activity.

Hydrotherapy

Hydrotherapy is therapeutic exercise completed in an aquatic environment, in which we use the influences of the water on the body. The biggest advantage of exercising in the water is that we can train the muscles without excessive loads on the joints because of the partial or non weight bearing in the water. This reduces joint compression. The water characteristics have all a different influence on the body : buoyancy, relative density, viscosity, hydrostatic and hydrodynamic pressure, resistance and thermodynamic effects. The patients that benefit from hydrotherapy are orthopaedic and neurological patients, conservative or postoperative, but also the sporting dogs or dogs with overweight that come in for conditioning and/or water habituation. The treatment goals for hydrotherapy is to improve muscle strength, muscle aerobic fitness, cardiac and pulmonary conditioning, ROM, flexibility, coordination, balance, core stability and metabolism.

Of course there are some precautions/contraindications we have to consider. And also not every dog or pathology benefits with hydrotherapy. We have to be careful with patients with conservative patellar luxation, total hip replacement, cervical issues, immediately postop TTA and TPLO, muscle/tendon pathology, … For some patients it is necessary to choose for controlled underwater treadmill training over uncontrolled swimming. In our rehab center we find it very important that the therapist is in the water with the dog to guide the movements in the water and to give extra manual resistance to train the specific muscle groups.

Last but not least : hydrotherapy is a form of therapeutic exercise and is not a stand alone treatment. It is one of the treatment techniques that we can use in our treatment plan, if the treatment goals indicate the beneficial use of the water.

CONSERVATIVE MANAGEMENT OF SHOULDER LESIONS:

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Shoulder problems are common causes of lameness in dogs, especially (but not only) in sporting dogs.

With the coordination of over 25 muscles required for shoulder motion, the ensuring action is complex, with the limb undergoing flexion, extension, rotation, abduction and adduction.

The most common injuries (but not the only ones) in shoulder are subscapularis tendinopathy, supraspinatus tendinopathy, biceps tendinopathy and infraspinatus myopathy.

Rehabilitation in these patients is very important, especially in canine athletes, because in these working dogs we need to take care not only about proprioception, cardiorespiratory function, muscle strength, endurance, flexibility and coordination, but we need to have a healing very close to 100% to avoid further injuries.

During the rehabilitation period, after injury or surgery, the patients could receive every kind of physical therapy in relation of the main problem.

The goals of rehabilitation include first of all the tendons healing, restoring or maintaining a proper joint ROM, preventing or reducing tendon adherences, improving muscle strength, restoring neuromuscular function, a proper proprioception and preventing any further trauma during work or daily activity.

We could use instrumental modalities, manual therapy and aquatic exercises, generally a mix of these.

PROM exercises and stretching are really important to maintain a good joint ROM and the stretching is important for affected and antagonist muscles, in fact the loss of tone of antagonist muscle groups predisposes patients to joint contractures, so massage could be beneficial too. Exercises on physioroll / physioboard, balance board, specific exercises for proprioception (especially in old dogs), neuromuscular balance and coordination or exercises challenged to stimulate weight bearing and underwater treadmill could be beneficial too.

If we have some instrumental modalities we can use neuromuscular electrical stimulation (NMES) for muscle strengthening; therapeutic ultrasounds to decrease muscle guarding and spasm, modify cellular function and membrane permeability, increase sensory and motor nerve conduction velocities and improve nerve, muscle and tendon healing; laser therapy or diathermy could be useful to treat pain, trigger points and have a faster healing of soft tissues treated.

Personally, I think that diathermy is one of the most useful modalities to have a faster and excellent healing on tendons and muscles. Some studies (*1. Bansal P.S., Sobti V.K., Roy K.S.: Effects of diathermy in the healing of experimental tendinous injury in dogs. Indian Veterinary Journal, 6, 69, 1990: 583 – 584. and 2. Bansal P.S., Sobti V.K., Roy K.S.: Effects of diathermy in the healing of experimental muscular injury in dogs. Indian Veterinary Journal, 4, 68, 1991: 336 – 339.*) demonstrated that with diathermy we have a faster tissue repair with a well-organized granulation tissue than in the animal in the control group, and an early restoration of the functional strength of the traumatised muscle.

Very often I (LD) associate more than one instrumental modality to achieve the maximum benefit from each. In my personal experience, for musculotendinous injuries I prefer to associate diathermy and ultrasounds, to improve vascularization, to have more "normal tissue" avoiding fibroconnective and anelastic tissue and to have the best possible healing with a perfect functional activity of the muscle / tendon.

For tendons I use diathermy at 25% of power and ultrasounds at 3.3 MHz and 0.5 – 0.7 W/cm^2; for muscles I use diathermy at 30% of power and ultrasounds at 1 MHz and 1 – 1.5 W/cm^2.

After that I perform some gentle passive exercises to avoid or to contrast the formation of adherence between the tissues and then underwater treadmill to improve muscle tone, joint movement and joint stability and to stimulate a proper posture, without excessive stress on the joints.

After an injury we need to do our best to avoid further injury when dogs will come back in a performance or in a normal daily activity. For this reason, stretching and a proper warming-up and cool down session are required.

USE OF 448 KHZ RADIOFREQUENCY IN VETERINARY MEDICINE

Marc-Ignasi Corral-Baqués, Medical Advisor for INDIBA S.A. and SOR International S.A.

There are many energy based technologies used in VET medicine and rehab, among these radiofrequency (RF) could be considered one of the most versatile. Radiofrequency bases its effects on rising up tissue temperature and the local physiologic reactions it triggers. But not all radiofrequencies work in the same way nor are they bio-equivalent. Although strong importance is given to the modality of application (polarity) not much is given to the frequency. It has been proven that at a certain frequency, that of 448 kHz, other effects apart from those related to hyperthermia application can be achieved; subthermal output power application (not increasing significantly tissue temperature) leads to a wide range of uses of special interest, such as acute inflammation control and regeneration as well as post-op care. But RF is not reduced to healing, it also can be used to enhance sport animals performance.

PREHABILITATION

Ilke Alaerts, DVM, CCRP

Definition:

Prehabilitation is the practice of therapy based movements and exercises in order to avoid injury, decrease pain or to prepare for surgery.

Before surgery prehabilitation aims for an improved postoperative outcome. (Better in – Better out). More and more evidence is becoming available that prehabilitation reduces length of stay, postoperative pain and postoperative complications.

Interest in prehabilitation is also great in the field of sports medicine, where it is used as a preventative mechanism to decrease the risk of injury or even optimize the functional ability or quality of life of an athlete.

The Literature:

The term prehabilitation was first introduced in a scientific context in 1946. 'Prehabilitation, rehabilitation and revocation in the army'(1) recounts how the British Army developed a prehabilitation program as part of an experiment to increase the quality of young recruits, of which many where suffering from malnutrition and poor lifestyleand, consequently, were in poor physical condition. The program consisted of training for warfare, physical therapy and strength training for the whole body. Of the 12000 men gonig through the program, 85% improved.

The interest in prehabilitation was then picked up on again in the 1980s, mainly in the world of sports medicine (2). The focus at this time was on preventing injury in the athlete.

In the early 21st century, Topp et al.(3) and Ditmeyer et al. (4) suggested a theorethical model of prehabilitation: presurgical exercise aiming to improve functional capacity before a surgical procedure leads to more rapid postoperative recovery compared with patients who remain physically inactive through the postoperative period.(4)

During the last 20 years numerous studies have been conducted to investigate the effect of prehabilitation programs, physical activity always being the main component in all programs.

Components:

There may be several weeks between the decision to proceed with surgery and the actual surgery. This time can be used for prehabilitation.

The benefits of a multimodal approach become more clear throughout veterinary medicine in general and so too a prehabilitation program should consist of(5):

- Medical optimization

- Physical exercise
- Nutritional support
- (Psychological support)

Medical optimization:

Pain management can not be underestimated when it comes to normal movement and function of the body. Also general health should be in optima forma when goning into surgery as both muscle strength and cardiorespiratory fitness decline in the postoperative period.

Physical exercise

Muscle imbalance can alter normal functions in the body, changing both the way joints are loaded and the mechanics of our movements. This can trigger compensations throughout the entire body, which can cause dysfunction in other areas. Thus prehabilitation should focus on mobility, stability and strenght training for the entire body, with additional focus on injury-prone or injured areas.

Nutritional support

Prehabilitation is also the perfect time to adress weight related issues. Underweight patients experience more postoperative complications while overweight patients have a higher risk at wound infections, intraoperative blood loss and generaly have longer operation times.

It might also be the perfect time to start up supplements

Psychological support

Although less recognised and perhaps needed in veterinary medicine. Keeping the mind busy while an animal is hurt, will reduce stress. Stress is known to produce immunological dysregulations which contribute to greater postoperative pain, delayed recovery, postoperative complications and impaired wound healing. (6)

An extra benefit can be that the animal can get used to the practice of physiotherapy and physical exercises during prehabilitation for the rehabilitation phase after surgery.

Implementation into veterinary science:

Although there is an increasing support for broader prehabilitation programs in human medicine, the practice has yet to seep through in veterinary medicine and literature is lacking.

The practice of prehabilitation is becoming more and more inbedded into sports medicine, more commenly known as balance and fitness for example, where the focus lies on training the whole body through stabilisation, mobilisation and strength training. Focussing on sport-specific needs and weaknesses of the individual athlete are areas where we could also use more research.

Although the principles and goals of prehabilitation before surgery are logical and clear, most of our pets do not have long waiting times between the decision to operate and the actual surgery, therefore limiting the possibilities to participate in prehabilitation. A question to ask ourselves is: are there cases where we should chose prehabilitation before surgery over immediate surgery and thus reducing complications and have faster and better recoveries?

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NOVEL THERAPEUTIC APPROACHES IN CHRONIC INFLAMMATION

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The number of patients with chronic inflammation is increasing worldwide, both in human and (companion) animals. Currently, many of these patients require lifelong administration of immunomodulatory drugs, which cause generalized immunosuppression and hereby only partially alleviate the symptoms but do not cure the disease. Besides these drugs are inevitably associated with a risk of immediate or late-occurring severe adverse effects (e.g., life-threatening infections, cancer). Different approaches can be taken to enhance therapeutic efficacy, reduce side effect or even targeting the fundamental cause of inflammation, i.e., loss of immune tolerance will provide the next steps forward.

One approach is local administration of controlled release systems combined with anti-inflammatory drugs for the long-term inhibition of inflammation for example in osteaoarthritis (OA). Celecoxib, a selective COX-2 inhibitor, was the first drug to be approved for OA, it has anti-inflammatory effect and has been shown to have beneficial effects on cartilage, subchondral bone and synovial tissue, although side-effects were reported. Intra articular and intradiscal delivery of nonsteroidal anti-inflammatory drugs can be an alternative treatment strategy to halt degeneration, inflammation and reduce pain. Local and sustained delivery of celecoxib was as shown by reduced joint decreased inflammation. Follow-up clinical studies in canine patients are currently being performed.

Although local and sustained released enhances therapeutic effects, and reduces the risk of potential side effect, this type of treatment does not instigate a cure. Technologies that enable induction of therapeutic tolerance may revolutionize the treatment of autoimmune diseases by their supposed potential to induce drug-free and lasting disease remission. To re-instate natural self-tolerance it seems essential to induce tolerance for the critical autoantigens involved in disease. For example the induction of oral tolerance with oral collagen application might be such an approach in the case of arthritis where immune responses to collagen have been identified. However, for most chronic inflammatory diseases antigens involved is poorly defined. This is the case for both disease inciting autoantigens and antigens that become involved through epitope spreading. Moreover, re-establishment of tolerance in the presence of an ongoing inflammatory process has remained challenging. The development of cell-based therapies is clinically attractive for many reasons, not in the least through their potential of being of low-toxicity, to simultaneously control many different inflammatory cells and induction of antigen-specific immunity. Since tolerogenic DCs (tolDCs) have the combined capacity of mitigating antigen-specific inflammatory responses and of endowing T cells with regulatory potential, combining the anti-inflammatory qualities of tolDCs with disease relevant antigens as the ultimate curative treatment in chronic inflammatory diseases. Heat shock proteins might be a suitable antigen , not only abundantly expressed in inflamed tissues, but various studies have shown these proteins can function as vaccines to downregulate a variety of autoimmune inflammatory diseases.

This approach may possibly lead to future re-establishment of self-tolerance in autoimmune conditions, leading to a lasting and therapy free remission of disease.

PHYSIOTHERAPY AS A POSSIBILITY TO INCREASE QUALITY OF LIFE IN OLD DOGS

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Many changes occur over time with the aging process and can prove to be a challenge in the diagnosis, medical management, and rehabilitation of older dogs. The age at which dogs are considered "geriatric" varies from breed to breed, ranging from 10.5 years for small dogs to 7.5 years for giant breeds. Ageing has both metabolic and physical effects such as reduced metabolic rates, immunocompetence, phagocytosis and chemotaxis and/or loss of muscle, bone and cartilage mass and reduced cardiac output. As a result, geriatric animals are more prone to a variety of diseases such as degenerative joint disease, disc disease, degenerative myelopathy, cardiomyopathy, neoplasia, hypothyroidism and many others. Most of these conditions are chronic and require lifelong treatment and exceptional owner compliance. In addition, it is important for the therapist to understand the impact of these diseases on the function and activities of daily life. For example, hypothyroidism can cause lethargy in dogs and can easily be mistaken for arthritis or pain-related inactivity. The most significant systems related to rehabilitation are the musculoskeletal and nervous systems. Many changes may occur in these systems, including a reduction of muscle- and bone cells, diminished muscle function, the development of DJD, and cognitive dysfunction[1].

In order to maintain and/or improve the quality of life of patients, geriatric support programmes should be carried out as part of a wellness screen for animals aged eight years and older and should consist of various strategies.

1. Diagnosis and management of age-related disorders such as DJD with conservative pain treatment and physical therapy modalities for pain control.

2. Control of body weight

3. Low impact exercises such as swimming, training on underwater treadmills and therapeutic exercises to maintain or improve muscle mass, joint function and proprioception.

4. The environment of the animal should be adapted as far as possible to the special needs.

Pain management

The use of NSAIDs for the treatment of osteoarthritis-related pain is recommended, but care should be taken because of the slow metabolism of many drugs in older animals and that close laboratory tests should be performed to detect liver or kidney problems.

The use of physical therapy modalities is recommended:

1. TENS or Low Level Laser therapy can be used as effective additional pain management strategies

2. Modalities such as hot packs or cold packs may be used to help decrease pain with little to no side effects

3. Massage also offers support in pain management of geriatric patients

Control of body weight

It has been proven that overweight animals suffer more frequently from osteoarthritis and have a shorter life span than lean animals [2], a weight reduction improves clinical signs of OA related lameness [3] and that the combination of a weight loss program and physical therapy has a positive effect on the body weight and lameness [4]. Therefore it is recommend combining a weight loss or weight maintenance program with low impact therapeutic exercises on underwater treadmills together with a controlled home-exercise program such as swimming and leash-walks.

Maintenance /improvement of muscle mass, joint function and proprioception

Like humans, aging animals exhibit decreased muscle mass, impaired joint function and proprioception. This might be a result of orthopaedic and neurological disorders, but can also be present in clinically sound animals. The methods of physical therapy offer a wide variety of modalities which can be used to counteract these age related problems:

1. Training on an underwater treadmill improves muscle mass, joint function and proprioception and is excellent fitness training. The training on land-treadmills is also possible.

2. Active exercises are excellent possibilities to improve muscle mass, joint function and proprioception. They should be carefully adapted to the needs of the special patient to minimize the risk of injury. Useful are for example

- Slow walks on different ground surfaces like grass and sand

- Wobble boards and balls and obstacle training

- Sit-to-Stand and Give-Paw exercises improve joint function and muscle mass

Environmental modifications

Adapting the environment to the special needs of the geriatric patient is important to improve the animals' quality of life. For example a soft, well-padded bed or waterbed should be provided, anti-slip floors should be provided to avoid slipping and falling, stair climbing should be minimized and ramps should be used to help the animal getting into the car.

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FITNESS AND BALANCE

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In human medicine, fitness is considered a state of well-being that allows a person to perform a certain function and/or enables the person to adapt to or cope with various situations. Human fitness tests have been designed and validated depending on age, health, specific disorders, organ systems and function. In the past, threshold data such as maximum oxygen uptake or muscle torque were acquired in laboratory settings to test human fitness. These data were frequently difficult to interpret without specialized expertise (Rikli and Jones, 2013). More recently, standardized field tests such as the Senior Fitness Test have been developed for assessment of human strength, endurance, agility, and balance. They require minimal instrumentation and only basic training for health professionals (Rikli and Jones, 2013). These fitness tests are not only designed for comparison of the individual’s functional ability to a peer population, but also allow to identify and counteract specific weaknesses, while monitoring progress. Injury prevention and prediction depending on fitness level play an important role in human medicine, not only for the geriatric/senior population, but also for athletes (McGuine et al., 2000, Rikli and Jones, 2013).

In companion animals, exercise-induced physiological responses have been well documented in search and rescue dogs, agility dogs, military and sled dogs under different environmental conditions (Calogiuri and Weydahl, 2017; Pellegrino et al., 2018; Queiroz et al., 2018; Robbins et al., 2017). However, there is a relative paucity with regard to validated canine/feline fitness tests and comparative population data are currently still missing. Frequently, canine fitness tests focus primarily on cardiorespiratory health, such as the collaborative breed specific treadmill fitness test, that is currently established for pugs in Europe. Similarly, in a recent study, the beneficial effect of dietary supplements on fitness of drug detection dogs, was also primarily based on heart recovery during treadmill exercise (Menchetti et al., 2019). Task related performance in the field is less frequently evaluated in dogs. Questionnaires like Canine Brief Pain Inventory, Canine Orthopedic Index or Client Specific Outcome Measures, that are rather tailored to dogs impaired with osteoarthritis have been employed to assess function/fitness in dogs. In a recent study (Baltzer et al., 2018), fitness of healthy police dogs was evaluated utilizing questionnaires for functional assessment of fitness combined with the canine orthopedic index. Functional assessments scores, based on performance during the hup maneuver, when climbing the A frame, negotiating staircases and 1 m jumps in an obstacle course, were abnormal in 72% of dogs. The relationship of injury risk and functional assessment scores was not investigated in this study.

Balance, has been defined as the ability to maintain the body’s center of gravity within its base of support with minimal swaying. The ability to maintain equilibrium relies on visual, vestibular and proprioceptive feedback. Deficits of the sensorimotor input compromise balance and have been shown to increase the risk for injuries in people (McGuine et al., 2000). Thus, postural control appears to be an interesting parameter that should be also routinely evaluated in canine fitness tests. Hemistanding and –walking, and observation of balancing maneuvers, while equilibrium is manually challenged by the observer are crude basic static and dynamic tests, that are commonly utilized in practice. Age, breed and sport specific normal values for dogs have not been defined yet. In dogs recovering from intervertebral disc disease, postural control has been evaluated using validated open field scores, treadmill-based stepping and coordination scores, but the authors recently suspected that these evaluation schemes may not be adequately sensitive to detect subtle deficits in postural control (Blau et al., 2017). In people, center of pressure variability measured under stable and dynamic conditions with force platforms has been used to assess balancing capabilities. In dogs, center of pressure variations can be measured reliably in healthy chondrodystrophic dogs walking on treadmills (Blau et al., 2017). A recent study showed that craniocaudal center of pressure variations were higher in dogs with chronic spinal cord injury compared to normal dogs (Lewis et al., 2019). The reliability and applicability of dynamic forceplatforms for balance assessment and training in dogs has not been investigated yet. Further research is necessary to test whether these technologies are suitable for balance training and assessment in companion animals.

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SHORT-TERM IMPACT OF A MANUAL THERAPY SESSION ON GAIT SPATIO-TEMPORAL PARAMETERS IN 22 DOGS WITH HINDLIMB LAMENESS

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Aim: To assess whether the effects of a manual therapy session are detectable and quantifiable using a gait analysis system in the lame dog.

The dogs: 22 client-owned dogs, aged from 10 months to 12 years, of various breeds and with hindlimb lameness.

Materials and method: Gait analysis was performed by means of the Gaiterite® walkway system, just before the consultation, then 20 minutes after the treatment, and at D7 and D21. Pressure distribution and gait symmetry were compared by calculating the ratios (symmetry indices) for two parameters : the relative Maximum Support pressure (Pmax), and the support phase duration (SPD). The treatment combines massage techniques with indirect myotensive and osteopathic techniques. Lameness and pain were also subjectively assessed (scores), and goniometric measurements realised.

Results: In all cases (22/22) a significant quantifiable change in Pmax and/or SPD was observed immediately after treatment. In 85% of the cases, relative Pmax was increased on the affected limb, the Pmax and SPD ratios between the left and right forelimbs and hindlimbs were closer to (or returned to) the reference value of 1, the Pmax ratio between front and hind legs went closer to the reference value (equal to 1.5). In 20/22 dogs, these changes were maintained at least until D7, and correlated with clinical improvements (decrease in lameness and pain, improvement in joint ROM).

Conclusion: This study shows an objectivable immediate and short-term impact of manual therapy treatment on the postural pattern with a clear tendency to rebalance load distribution and stride symmetry improvement.

EFFICACY OF INTRAARTICULAR POLYACRYLAMIDE HYDROGEL IN CANINE JOINTS WITH OSTEOARTHRITIS

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Introduction: Polyacrylamide hydrogel (PAAG) (Noltrex®, Bionoltra SA) is a non-toxic and non-immunogenic biocompatible polymer gel consisting of 97.5% sterile water and 2.5% cross-linked polyacrylamide. Its biocompatibility in soft tissues (e.g. reconstructive surgery, urology) has been demonstrated. Also, it is a non-particulate homogenous gel similar to sodium hyaluronan gel in overall structure and tissue compatibility, but with a longer-lasting viscous effect, as it is non-degradable. The purpose of this prospective clinical study was to investigate the efficacy of PAAG for improving clinical signs of osteoarthritis in the canine joints.

Material and Methods: Five dogs older than 5 years with osteoarthrosis in only one or more joints (a total of 10 joints) were injected with 1,5-2 ml of PAAG into the affected joint and were followed up at 3 months. Efficacy of PAAG was evaluated before and after treatment by an owner evaluation (*Canine Braif Pain Inventory - CBPI*), a clinical evaluation (*Bioarth Functional Evaluation Scale*) and a kinetic analysis (*GRF:* including peak vertical force (PVF) and vertical impulse (VI) and symmetry index (SI)).

Results: There was a statistically significant clinical improvement in the evaluation through the *CBPI* (Wilcoxon, $p<0,05$) from the baseline to post-treatment. At the evaluation, dogs improved clinically on the *Bioarth Functional Evaluation Scale*. Significant differences were observed in the *PVF, IV* and *SI* between pre and post-treatment (Wilcoxon, $p<0,05$).

Conclusion: PAAG significantly alleviated the clinical signs of osteoarthritis in dogs.

WARM-UP EXERCISES IMPROVE MUSCLE FUNCTION IN AGILITY DOGS. AN ACOUSTIC MYOGRAPHY STUDY

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Introduction: Warm-up exercises might improve neuromuscular function and thereby help to reduce the risk of injury in agility dogs. Acoustic myography is a non-invasive method to study muscle activity by measuring pressure waves generated by muscle contractions. The aim of this study was to investigate the effects of warm-up exercises on two major muscles involved in locomotion.

Material and Methods: Fourteen large (≥46 cm at the withers) agility dogs of different breeds performed a 5-minute warm-up exercise program three times, with a 2-minute break between programs. The programs included walking, trotting, cantering, weaving, figure-eight and cavalettis. Piezoelectric sensors (CURO-Diagnostics ApS) were attached over the skin of m. triceps brachii and m. gluteus superficialis. While the dogs trotted before warm-up and after each 5-minute program of exercises, recordings were made to a CURO unit, and analyzed for muscle efficiency as well as amplitude (spatial summation) and frequency (temporal summation).

Results: The dogs used m. triceps more efficiently (more fiber resting time/total time) after 5 minutes ($P<0.05$), 10 minutes ($P<0.05$) and 15 minutes ($P<0.001$) of exercise compared to pre-warm-up values (ANOVA). Triceps muscle function (combined efficiency, amplitude and frequency) improved after 10 minutes ($P<0.05$) and 15 minutes ($P<0.01$). No changes were found for the gluteus muscle.

Conclusion and clinical relevance: The results for triceps indicate that warm-up exercises improve muscular efficiency/coordination as well as the overall muscle function in dogs. Warm-up should be recommended in canine sports, and a 10- or 15-minute program appears to be more effective than a 5-minute program.

WATER AT THE MID-FEMUR LEVEL REQUIRES MORE MUSCLE WORK THAN A SHALLOWER WATER LEVEL FOR HEALTHY DOGS WALKING IN A WATER TREADMILL

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Introduction: Water treadmills are frequently used in canine rehabilitation, but little is known about the muscular workload incurred during activity at different water depths.

Material and Methods: An acoustic myography unit (CURO-Diagnostics ApS) was used to assess hind limb muscle activation in 25 healthy large-breed dogs while they walked in a water treadmill at four different water depths: (1) the bottom of the pads, (2) the hock, (3) the stifle and (4) the mid-femur. Acoustic myography sensors were attached to the skin over the quadriceps muscle and over the biceps femoris muscle. The recorded signals were analysed for changes in three muscle function parameters: efficiency/coordination as well as spatial (fiber recruitment) and temporal (firing rate) summation.

Results: When walking in water (speed 50 m/min) at the mid-femur level, the biceps femoris was less efficient ($P<0.001$), recruited more fibers ($P=0.01$) and used a higher firing rate ($P=0.03$) compared to the workload in shallow water. At the mid-femur level the quadriceps was less efficient ($P<0.01$) compared to the workload in shallow water. Walking in water depths at the stifle or the hock did not show a higher degree of muscle activation for either muscle compared to walking in almost no water.

Conclusion and clinical significance: More muscle activation is required to walk in water depths above the knee joint compared to shallower water, and this exercise is more demanding for the biceps femoris, a muscle engaged in propulsion, than for the quadriceps. These findings enable practitioners to make more precise rehabilitation protocols.

Proceedings Equine Program

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THE HORSE-SADDLE-RIDER INTERACTION

Annamaria Nagy

For optimum performance, the horse and rider should move in complete synchrony and balance. A good rider absorbs and follows the horse's movements. The saddle creates the interface between the rider and the horse's back. The interrelationship between the horse, the saddle and the rider can be compromised by issues with any of these three components of the unit and can result in poor performance; most commonly characterised by back pain and dysfunction.

The rider can have a great influence on the horse's movement. A skilled rider can 'help' the horse by making small adjustments in order to maintain the symmetry of movement and balance and an underlying gait abnormality may only become apparent when the horse is ridden by a less skilled rider or the problem becomes severe enough to manifest in overt lameness or loss of performance. A crooked rider or a rider in pain can ride asymmetrically, which results in asymmetrical forces and pressure on the horse's back and can lead to back pain and asymmetrical movement. The rider's weight impacts the horse's gait; it has been shown that a heavy rider can induce temporary lameness. Long-term effects of a rider too heavy for the horse is currently not known and is assumed to be affected by other factors such as the height, skills, experience and the ability of the rider to ride in balance.

The saddle should fit both the horse and the rider. Static assessment should be carried out before and after work as exercise can alter back dimensions. Saddle fit should be assessed while the horse is moving; it should fit the horse in a variety of paces and movements and allow the rider to move in synchrony with the horse. A poorly fitting saddle can cause abnormal pressure and back pain and even gait abnormality. In can also put the rider out of balance and/or make it difficult for them to fluidly follow the movements of the horse. The most common problems with the fit of the saddle include incorrect size (for the horse and/or rider), bridging (uneven distribution of forces, resulting in increased pressure cranially and caudally with a gap in between) and tight tree points. The saddle fit should be checked frequently; the shape of the horse's back can change in as little as two months when in training.

The horse (its back shape and movements) can have an influence on the rider and the saddle. Saddle slip has been associated with hindlimb lameness (most commonly towards the lame limb), but it can also occur due to poor saddle fit, a crooked rider or asymmetry of the horse's back musculature. Asymmetrical movement due to lameness can alter the rider's ability to ride fluently and symmetrically and may result in asymmetry in the rider themselves. A horse with primary or secondary thoracolumbar or sacroiliac joint region pain moves with its back held stiffly, which can alter the fit of the saddle, particularly if it had only been fitted statically and not when the horse is ridden. A back with reduced range of motion can jar the rider and diminish their ability to absorb the horse's movement and follow it fluidly, particularly in sitting trot and canter when contact between the rider's body and the horse's back is continuous.

Due to the close relationship and interactions between the horse, saddle and rider, it is paramount that any poor performance and/or back pain investigation includes ridden evaluation and static and dynamic assessments of the fit of the saddle.

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DIAGNOSING CARDIAC AND RESPIRATORY DYSFUNCTION IN SPORT HORSES

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Introduction

Cardiac disease is common in sports horses, often manifesting with pathological cardiac murmurs and/or dysrhythmias. [1] However, in many situations these are not performance limiting and it is generally uncommon for horses to develop performance limiting congestive heart failure, especially as a result of valvular heart disease during the normal competitive timespan of elite athletes. Diagnosis relies upon a thorough physical examination, electrocardiography and/or echocardiography. [2,3]

Respiratory disease is an important cause of poor performance in horses this session will focus on the evaluation of lower respiratory tract disease in the horse, for which non-contagious causes are important in the older horse, while contagious causes are more important in young horses. While acute viral respiratory disease caused by equine influenza virus has received particular focus in 2018-19, other viruses including EHV 1-4 are often overlooked. Equine Asthma syndrome is the term used to define non-infectious chronic respiratory disease previously referred to as inflammatory airway disease and recurrent airway obstruction. [4]

Evaluation of horses with cardiac murmurs

The cause of most cardiac murmurs can be documented using cardiac auscultation; other physical examination findings can be useful to document severity of disease, such as the intensity of the third heart sound in horses with mitral valve disease and the pulse pressure of horses with aortic valve regurgitation. [5]. Physiological murmurs can usually be differentiated from pathological murmurs by their point of maximal intensity and timing, with murmurs of aortic ejection being loudest over the left 4th intercostal space and diastolic physiological murmurs being mid diastolic. Two-dimensional echocardiography can be used to document valvular pathology, myocardial function and chamber enlargement. While Doppler echocardiography can document the severity of valvular regurgitation and document pressure differences between different structures using the Bernoulli equation. Markers of severity and potential consequences of each disease have been used to create the current consensus recommendations for assessing cardiac disease in equine athletes [6] and although many of these recommendations remain valid, recent research has documented further tools to evaluate severity of disease. These will be considered in below. Most cardiac murmurs in the horse are caused by degenerative endocardiosis and therefore are progressive conditions. Horses with bacterial endocarditis or rupture of their chordae tendinae usually have severe and acute onset of disease and are more likely to present in congestive heart failure. Laboratory markers of cardiac disease have been identified in other species, but have yet to be evaluated to the point of clinical use in the evaluation of cardiac valvular disease. Cardiac troponin concentrations are used for the management of severe myocardial necrosis and can be seen to be increased in horses undergoing electrocardioversion, [7] following maximal exercise[8] and in horses following infusion of endotoxin. The author rarely finds clinical indications to assay cardiac troponin concentrations. [9]

Mitral regurgitation

Mitral regurgitation is a common condition in the equine athlete and can result in left atrial enlargement. Poor exercise tolerance usually results from secondary atrial fibrillation rather than a reduction in cardiac output. Loud third heart sounds predict left atrial enlargement and can be useful in documenting severity of disease. Horses with left atrial enlargement should undergo regular re-assessment to document the rate of progression, although generally this is slow.

Aortic regurgitation

Aortic regurgitation is more associated with ageing in horses and tend to be diagnosed in horses over 15 years of age. Again, this condition is progressive and although can lead to a reduction in cardiac output, the greater concerns is the development of exercise induced ventricular dysrhythmias. [6] These are of concern as they may predict dysrhythmias such as ventricular tachycardia that can be associated with collapse and or sudden death at exercise. Recently echocardiographic measures of severity, using aortic diameter change and pre-ejection period have been shown to predict severity of disease, although Doppler characteristics are less reliable. [10] Equally changes in pulse pressure may predict severity of disease. [5]. These measures have yet to be applied in longitudinal studies to document their prognostic value.

Other valvular regurgitations

Murmurs caused by regurgitation of valves of the right heart are less commonly associated with significant disease, although severe tricuspid valve disease can be associated with the development of atrial fibrillation due to right atrial enlargement. The tricuspid valve maybe a more common site for the development of bacterial endocarditis secondary to jugular thrombosis. Pulmonary regurgitation (PR) is poorly understood in the horse and murmurs caused by this are rare given the low pressure in the pulmonary circulation. PR is a common incidental finding on echocardiography

Congenital cardiac disease

Ventricular septal defects (VSDs) are the most common congenital cardiac abnormality of the horse and while they can be exercise limiting, those that are restrictive can be found incidentally in horses competing successfully. [11] [6]The impact of closure of such defects has not been documented. Other congenital cardiac abnormalities have been documented and these are rarely well tolerated and therefore often not found in elite athletes. A case report of an atrial septal defect is presented in the poster session.

Disorders of the aortic root

Dissecting lesions of the aortic root are reported in old horses, especially entire stallions and also in horses of the Friesian breed at any age, associated with a collagen abnormality. [12] [13] These conditions are usually life threatening and such horses should not be considered suitable for ridden exercise.

Cardiac dysrhythmias

The most important cardiac dysrhythmia in the athlete is atrial fibrillation (AF), although sudden death caused by undocumented cardiac dysrhythmias are thought to be a cause of collapse and sudden death in horses during intense exercise. Considerable work is ongoing to document the causes of these and predict which animals will develop abnormalities including the use of machine learning of ECG abnormalities [14]. Management of AF has undergone significant changes and the reliance on pharmacological control has been largely superseded by transvenous electrocardioversion. [15] The evaluation and management of paroxysmal atrial fibrillation remains a challenge in equine cardiology and the role of atrial ectopic activity in this condition is facing renewed focus. [16]

Evaluation of horses with lower respiratory tract disease

Physical examination findings of horses with respiratory tract disease include evidence of respiratory noise. Stridor is a harsh inspiratory noise associated with laryngeal disease or lower respiratory tract disease, while stertor is a gasping/snoring noise associated with upper respiratory tract obstruction. Coughing is usually associated with laryngeal / pharyngeal or lower respiratory tract disease and is rarely helpful in documenting sourcing of disease. Abdominal effort of ventilation is sometimes helpful to document inspiratory or expiratory respiratory distress. Characteristics of nasal discharge are often helpful in documenting sources and potential causes of respiratory tract disease. Respiratory auscultation is relatively insensitive for the diagnosis of low-grade respiratory disease but can be improved through the use of a rebreathing examination [17] or examination after a period of exercise. Dullness on percussion of the caudo-dorsal lung lobes has been identified in 50% of horses with EIPH. [18]. Assessment of lower airway disorders remain important even in animals with dynamic airway disease since changes in airway dynamics in the lung can result in changes in pressure in the upper airway that may compromise laryngeal and pharyngeal function. Importantly, improving lower airway dynamics can often be effective in managing upper airway dysfunction.

Endoscopy and respiratory cytology

Respiratory cytology is the mainstay of diagnostics for equine asthma and lower respiratory tract infections. Inflammation within the airways can be documented using different techniques, although bronchoalveolar fluid cytology provides information about the distal airways to the extent it has been described as a 'liquid biopsy', while a tracheal wash is often a historical reflection of material transported through the mucociliary escalator. Sterile samples for bacterial culture can either be obtained from a trans tracheal aspirate or by using guarded double lumen catheters. However bacteriology results should always be interpreted in light of the cytology and a knowledge of pathogens that affect the lungs. Importantly, responsible use of antimicrobials dictates the use of antibiotics only where relevant bacteria are identified. Lung biopsies are predominaty useful for the diagnosis of interstitial disorders, rather than luminal disease. [19]

Diagnostic imaging

Radiography is generally of little value in the assessment of chronic lung disease and has poor sensitivity for the documentation of equine asthma or EIPH. [18,20]. Radiography can be very helpful in the diagnosis of nodular pulmonary diseases, such as equine multinodular pulmonary fibrosis. In horses with pleural effusion, radiography fails to document any underlying pathology. Ultrasonography is limited by the gas contents of the normal lung and therefore is predominantly used to asses the pleural cavity, although lung consolidation can also be visualised if this reaches the surface of the lung. Comet tail artefacts consistent with localised lung consolidation and occurs with a variety of conditions and can be seen in most horses with EIPH. [21]

Intradermal skin testing and IgE determination

Equine asthma related to hypersensitivity has evaluated the use of allergy testing in a number of situations. Horses with disease have been shown to respond to fungal allergens [22] however its use in clinical cases is contradictory [23-27]. To date there are no published data to support the use of immunotherapy in horses with equine asthma and therefore the use of allergy testing in horses remains questionable

Lung function testing

Oesophageal balloon pneumotachography has traditionally been used as a method of documenting changes in airway pressures in horses with lower airways disorders leading to bronchoconstriction. Forced oscillatory mechanics is a less invasive procedure that has been shown to have good sensitivity for the detection of equine asthma. [28] These techniques are widely applicable to clinical practice and can be undertaken in lightly sedated horses. The technique determines impedence (resistance) within the respiratory system. Long

Conclusions

Evaluation of horses with cardiac and respiratory relies upon the use of robust clinical examination procedures as well as targeted diagnostic techniques. Diagnostic imaging and functional tests can used to document the impact of the disease on exercise tolerance.

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REHABILITATION OF EQUINE HERPESVIRUS MYELOPATHY PATIENTS

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Introduction

Equine herpesvirus 1 (EHV-1) is an alpha-herpesvirus and an economically important equine pathogen, exerting its major impact by causing abortion storms, sporadic abortions and respiratory disease in young horses. Incidentally, EHV-1 also causes

neurological disease in horses (Equine Herpes Myelopathy – EHM). EHM usually occurs in the form of outbreaks but is also encountered as isolated individual cases.

Clinical signs

Initially EHV-1 causes an upper respiratory infection characterised by fever, depression, nasal discharge and inappetence. Sometimes this episode is subclinical. Neurologic signs may develop 1 to 10 days after the initial EHV-1 infection; typically they reach peak severity within 1 to 3 days The first neurological signs include mild hind limb incoordination (ataxia) and weakness (paresis), and a decreased tail tone. At this stage pyrexia may still be present but the body temperature is more often normal or even sub-normal. It is essential that the attending veterinarian performs a rectal palpation to check the bladder. If the bladder is severely enlarged this supports the diagnosis of EHM. Bladder catheterisation 2-3 times per day is essential to prevent later incontinence. In severe cases hind limb incoordination progresses quickly to paralysis of the hind limbs and recumbancy. Sensory deficits in the perineal area and decreased anal tone with faecal retention are recognised less often. Rarely horses with EHM develop cortical, brainstem or vestibular disease characterized by depression, head tilt, ataxia, and cranial nerve dysfunction. Usually, the mental status and the appetite remain normal even in recumbent horses.

Confirmation of diagnosis

In an outbreak it is important to sample not only EHM cases. Significant diagnostic support can be gained by testing in-contact horses that are still febrile but do not (yet) show any other clinical signs. Quantitative polymerase chain reaction (qPCR) testing of nasopharyngeal swabs and/or EDTA blood is the best way to confirm the infection. Viral shedding through nasal secretions is at its highest during the first few days and generally persists for 10 to 14 days. Occasionally shedding can be detected for up to 28 days in some horses. It is wise to test secretions from both nasal cavities and EDTA blood since the post-exposure temporal profiles of EHV-1 in nasal secretions and leukocytes may not completely overlap. Cerebrospinal fluid (CSF) may help to confirm the diagnosis: xanthochromia, increased total protein concentration, positive qPCR can be found. However, CSF-tap is not easy to perform in practice.

Virus isolation or paired serum neutralization titres obtained 7 to 21 days apart are less frequently used because of the costs and the time necessary to obtain a diagnosis. The titre of an EHV-1 specific complement fixation assay (CFA) on a serum sample collected on the first day of neurologic presentation is often already increased. A post-mortem diagnosis of EHM is not always easy since the vasculitis may be very localized and is easily overlooked, but a spinal cord tissue sample for qPCR analysis often reveals presence of EHV-1 genome.

Management

Hospitalisation of EHM patients to ensure round-the-clock care is often considered to provide the best chance of survival. However, this depends heavily on the specific situation:

- Stress from transport to another location may exacerbate the patients situation
- Not every hospital has a suitable isolation unit and enough personnel to provide the necessary care

If a whole farm or riding school is affected, it may be better to organise a field hospital in an indoor arena or barn with a soft/sand floor where temporary individual pens can be constructed with large straw bales (400-500 kg each). This has the advantages of a soft and non-slippery footing and ‘padded’ walls. Volunteers to help are often readily available. Also, the removal of a dead horse is easier.

Treatment

The treatment of EHM-affected horses is challenging and often only partially based on scientific evidence.

The appropriate supportive care is:

- hydration – take care for enough water uptake
- nutrition – provide tasty hay or fresh grass
- rectal evacuation of retained manure (rarely necessary)
- sling support (discuss prognosis with owner)
- bladder care (catheterization and treatment of cystitis as warranted)
- walking horses at hand with enough helpers

A possible medication protocol is:

- Antithrombotic: Acetylsalicylic acid 6 mg/kg q 24h orally
- NSAID: Firocoxib (Equioxx®) 0,1 mg /kg q 24h orally

- Antiviral drugs: Valacyclovir (there are several commercial brands) with a loading-dose of 30 mg/kg orally q 8h for the first 2 days, followed by 20 mg/kg orally q 12h. The earlier this antiviral medication is instigated in the course of the infection the better. Medication should be prepared directly before administration, as the drug is subject to degradation. Sometimes higher doses up to 40 mg/kg q 8h orally are necessary.

In recumbent horses:

- Short-acting corticosteroids: Dexamethasone 0.02-0.04 mg/kg q 24h before 09:00 h i.v. or i.m.

In horses with bladder problems:

- 2-3 times per day bladder catheterisation
- After catheterisation flush the bladder with a povidone iodine (Betadine®) solution (10 ml Betadine® in 1000 ml NaCl 0.9%)
- If necessary: broad spectrum antibiotics can be used

The results of different treatments are very difficult to compare because of variations in immune status or virus load in EHV-1–exposed horses and the fact that this may have influenced reported results.

Prognosis

The prognosis for EHM-affected horses is highly variable and strongly dependent on the severity of the clinical symptoms and the effect of treatment. Mildly affected horses (i.e. horses that do not become recumbent) have a fair to good chance for a full recovery and a return to athletic performance. Recumbent horses usually do not fully recover and may be left with residual permanent neurologic deficits including ataxia and urinary incontinence.

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THE DILEMMA OF MEDICATING THE EQUINE ATHLETE

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Introduction

The UNESCO (United Nations Educational, Scientific and Cultural Organisation) definition of doping is:

'Doping' refers to an athlete's use of prohibited drugs or methods to improve training and sporting results. Steroids are the drugs that often come to mind when we talk about doping, but doping also includes an athlete's use of other forbidden drugs (such as stimulants, hormones, diuretics, narcotics and marijuana), use of forbidden methods (such as blood transfusions or gene doping), and even the refusal to take a drug test or an attempt to tamper with doping controls.

The FEI (Federation Equestre International) responsible for doping control in sport horses has the following terminology:

Any substance prohibited by the EADCM (Equine Anti-Doping and Controlled Medication) Regulations will be referred to as a Prohibited Substance which is now meant to be the umbrella term. However, substances classified as Doping under the EAD (Equine Anti-Doping) Rules will be referred to as Banned Substances while substances classified as Controlled Medication under the ECM (Equine Controlled Medication) Rules will be referred to as Controlled Medication Substances.

As horses participate in sport, doping is an issue that the rider (person responsible) and the owners, veterinarian, grooms and sponsors have to face. Horses (and riders) can be tested for drugs.

Horse Passport

All equidae in equine sports under the FEI must have a passport and a micro-transponder. On one hand this is important as the horse is considered to be a food producing animal species (rarely an issue in sport horses), on the other hand identification is very important in sport horses.

All horse passports include a medical treatment section.

I. Part I definitively excludes the animal from slaughter for human consumption and this must be confirmed if the animal changes ownership. The owner and his veterinarian should date and sign this statement and from that moment on, the horse is considered to be a non-food producing animal.

II. Part II consists of Part IIA and Part IIB. Part IIA is only valid with Part IIB.

In Part IIA the owner, or the representative of the owner, declares that the animal described in this identification document is intended for slaughter for human consumption and this statement is also signed by his veterinarian. Part IIB contains all the obligatory information for equidae intended for slaughter for human consumption. Here the veterinarian should record: date of last treatment with a medical product containing substances not included in Annex I, II or III of regulation (ECC) 2377/90. For all other veterinary treatments with medical substances the veterinarian should provide the owner with a logbook form with a description of the medical product used, the dose and the official withdrawal time.

Many sport horses are excluded for human consumption and thus medications are not written in the passport.

Prohibited substances

The FEI publishes an 'Equine Prohibited Substances List' (EPSL). This enables Persons Responsible (PRs) to ensure that they are not treating or feeding horses with substances that are prohibited for use during competition and substances that are not permitted for use in the horse at any time.

Prohibited Substances are categorised as follows:

- 'Banned Substances' are substances that are deemed by the FEI to have no legitimate use in the competition horse and/or have a high potential for abuse. They are not permitted for use in the competition horse at any time.
- 'Controlled Medication' are substances that are deemed by the FEI to have therapeutic value and/or be commonly used in equine medicine. Controlled Medication have the potential to affect performance and/or be a welfare risk to the horse.

The EPSL lists all substances that are prohibited for use during FEI events. Substances that are not listed on the EPSL are not prohibited provided that they do not have a similar chemical structure or biological effect to a substance listed on the EPSL.

Withdrawal time (FEI information)

A withdrawal time is not the same as a detection time. The detection time is the approximate period of time for which a drug (or its metabolite) remains in a horse’s system, such that it can be detected by the laboratory and is provided only as a guide.

The withdrawal time for a drug must be decided upon by the treating veterinarian and is likely to be based on the detection time and an added safety margin. This margin should be determined using professional judgment and discretion to allow for individual differences between horses such as size, metabolism, degree of fitness, recent illness or disease etc. to be taken into consideration.

With all medications, a clinical judgment is essential to ensure that the welfare of the horse is never compromised by administering a drug at a time too close to an event such that it may mask symptoms and could aggravate a clinical condition. Horses with locomotor problems in particular must always be provided with adequate rest.

It is well-established fact among veterinarians that when a joint is injected, there is always a risk of leakage and it need to be taken into consideration when deciding the withdrawal time for a specific drug. It is also well-established fact that there may be a difference in detection time for a substance depending on the route of administration i.e. orally (p.o.), intra-articular (i.a.), intravenous (i.v.), intra-muscular (i.m.) and subcutaneous(s.c.).

Medication of the equine athlete

The FEI provides information on detection times. However, this information is based often on a limited number of healthy horses. In diseased horses detection times may be much longer. Some drugs are known for unexpected long detection times (i.e. acepromazine). Those drugs are not a wise choice shortly before a competition.

Drug provided in skin ointments may be absorbed and are a risk. An antibiotic as procaine benzyl penicillin has a very long detection time.

Last but not least, remember that withdrawal period for slaughter is often much shorter than the detection time for doping control.

Studies have shown that re-uptake of drugs (e.g. dipyrone, flunixin, clenbuterol) through droppings of the horse or contaminated bedding can result in prolonged detection times. Therefore it is essential that stalls in which competition horses are under NSAID or other treatment are daily and thoroughly cleaned. This applies particularly to oral medication in boxes with straw bedding not replaced very frequently.

For FEI detection times see:

https://inside.fei.org/system/files/FEI%20Detection%20Times%202018_0.pdf

For FEI threshold substances list see:

https://inside.fei.org/system/files/2019%20Threshold%20List.pdf

FACTS AND FICTION ABOUT DIFFUSION AFTER DIAGNOSTIC ANALGESIA

Annamaria Nagy

The traditional views suggesting that perineural analgesia should desensitise regions distal to the site of injection and that intrasynovial analgesia is specific were first questioned by clinical experience. These clinical dilemmas initiated several experimental studies over the past two decades. A set screw shoe model has been used to assess the effect of various perineural and intrasynovial diagnostic analgesic techniques on solar pain. Radiopaque contrast medium has been used to demonstrate the likely route and extent of diffusion of local anaesthetic solution in the distal aspect of the limb and in the subcarpal and subtarsal regions. Studies focussing on the effect of diagnostic analgesia on intrasynovial pain have used a lipopolysaccharide-induced synovitis model. Other studies measured the concentration of local anaesthetic solution in tissues at possible diffusion sites following diagnostic analgesia.

It has been shown that there is a great overlap between regions desensitised by diagnostic analgesic techniques in the distal aspect of the limb. Perineural analgesia of the palmar digital nerve has the potential to desensitise a large part of the distal aspect of the limb, including the toe region of the sole, the distal and proximal interphalangeal joints, the proximal aspect of the pastern and even the fetlock joint region. The extent of diffusion is likely to depend on the injected volume and the injection site. Perineural analgesia of the palmar nerves at the base of the proximal sesamoid bones (abaxial sesamoid nerve blocks) can influence fetlock region pain in addition to the foot and pastern regions. Intra-articular analgesia of the distal interphalangeal joint can improve solar pain and pain originating from the navicular bursa and its associated structures.

Proximal diffusion can occur after perineural analgesia of the palmar and palmar metacarpal nerves just proximal to the digital flexor tendon sheath (low 4-point nerve blocks), but local anaesthetic solution is unlikely to diffuse to the proximal metacarpal region. However, inadvertent penetration of the digital flexor tendon sheath or the metacarpophalangeal joint may occur.

Significant proximal diffusion after perineural analgesia of the palmar metacarpal nerves in the subcarpal region is unlikely; however, inadvertent penetration of the distal pouches of the carpometacarpal joint may lead to desensitisation of the carpometacarpal and middle carpal joints. Inadvertent penetration of the carpal sheath may occur following lateral injection of the lateral palmar nerve. If injection is performed from the medial aspect, local anaesthetic solution might diffuse to the distal aspect of the antebrachium along the median and ulnar nerves. Following perineural analgesia of the deep branch of the lateral plantar nerve, local anaesthetic solution might be found in the tarsometatarsal joint and also in the tarsal sheath.

Intrasynovial analgesia is usually more specific than perineural analgesia, however, diffusion (via direct communication or other route) between synovial cavities often occurs when they are in close proximity (e.g., distal interphalangeal joint and navicular bursa, carpus, distal tarsal joints, compartments of the stifle joint) and leakage from the needle tract might lead to desensitisation of an adjacent nerve.

Limitations of diagnostic analgesia should not deter the clinician but prompt them to consider potential diffusion of local anaesthetic solution and to use all appropriate diagnostic analgesic techniques in a region to gain maximum information.

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FEEDING EQUINE ATHLETES

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Introduction

Horses have evolved for a continuous diet of poor-quality grass, meaning that fermentation of non-soluble carbohydrates by the hind gut remains the major method of energy utilisation. Domestication and the use as horses as elite athletes means that modern feeding has brought significant challenges to this evolutionary model in an attempt to promote exercise performance. In particular, high grain feeding in order to provide a rapid glycaemic response are high in starch and other non-structural carbohydrate (NSCs). In one study, thoroughbred horses were fed 7Kg of grain per day, while others have shown that less dependence on grain feeding in sports horses. [1] While feeding such large amounts of carbohydrate can be useful for horses undergoing intense exercise, this places additional burdens on the gastrointestinal tract and can result in important morbidities in the performance horse. The aim of this session is to review the current evidence of nutrition in the horse and identify opportunities to improve feeding for performance. The target of feeding for performance is to provide the necessary energy requirements, which can be up to twice that required at maintenance, without causing significant weight gain, which may limit performance. In the sprint athlete glycogen is the dominant energy supply for muscle and therefore maximising glycogen stores are beneficial. Muscle glycogen manipulation has been attempted through a variety of means and will be discussed.

The carbohydrate challenge

Grains contain large amounts of starch, that undergoes breakdown through the action of α-amylase to form simple disaccharides, trisaccharides and dextrins. These are subsequently hydrolysed into simple monosaccharides by brush border enzymes within the small intestine. These are then absorbed into the blood through a range mechanisms. The production and activity of α-amylase in horses is limited, resulting in a potentially rate limiting step in the management of grain feeding in horses. [2] The failure of digestion reduces the amount of available energy from grains and results in increases in large intestinal fermentation of starches that can be documented through the faecal microbiome . [3] Indeed, overflow of readily fermentable carbohydrates may have important effects on the prevalence of large intestinal colic [3] as well as on the availability of energy sources for performance. While this might encourage trainers to 'jump on the supplement bandwagon' and purchase supplements that are high in amylase, it should be borne in mind that the gastrointestinal tract has the ability to adapt to changes in diet through upregulation of enzyme production [4] and through the expression of glucose transport molecules [5]. Despite this, supplementation may allow feeding of starch beyond the current recommendation of a maximum of 1g/kg bodyweight . There is no evidence that high grain feeding can increase muscle glycogen concentrations and thus delay fatigue in the performance horse, at least within accepted nutritional guidelines. [6,7]

Feeding performance through fats

Fats and oils provide energy dense substrates that are particularly beneficial in horses with poor appetites, while also reducing some of the negative effects of feeding NSCs. Feeding of oil has been shown to increase muscle glycogen stores and is this particularly beneficial for the sprinter. [8,9] Furthermore oil supplementation has been shown to offset lactate accumulation and delay fatigue. [10] Oils are typically included at inclusion rates of up to 10% of feed.

Forage as food

Forage provides fibre and energy in the horse, and while most sports horse owners do not consider that this produces sufficient energy for performance. [1]. Energy from fibre is liberated from grasses and other non-soluble carbohydrates by bacteria and fungi within the caecum and remaining large colon that breakdown cellulose though a variety of mechanisms. Sugars from this breakdown are then fermented by bacteria leading to pyruvate production and subsequent production of volatile fatty acids. Low forage diets have been associated with a number of co-morbidities, that in part relate to changes in the intestinal microbiome. [11]. High forage diets are often avoided in performance horses since they increate gut fill and associated with lower energy provision, which are generally thought to be disadvantageous in performance horses. [12] However, more recent studies investigating the effects of high-energy forage only diets contradict the findings of these traditional forage based diets. [13] some fibre sources also have the ability to increase the retention of water in the large intestine, which may be an advantage in the endurance horse through the feeding of sugar beet.

Proteins in performance

Proteins are essential in the repair of tissues after intense exercise, Horses increase protein intake through intake in dry matter especially when fed good quality forage. When energy is being provided through oils and fats, this increase may not be seen and therefore protein content of the diet should be more carefully considered. Excessive protein feeding places additional burdens on the urea cycle, to breakdown unnecessary proteins that can result in greater heart production, resulting in an increase in evaporative fluid losses through sweat [14] but may promote muscle glycogen stores. [15] Although specific amino acid supplementation is widely promoted at human athletes, there is no indication that such is beneficial in developing lean muscle mass in the horse.

Clinical nutrition

Gastric disease

Feeding of forage plays an important role in the prevention of gastric pathologies. Horses fed forage spend more time chewing which stimulates the release of salivary bicarbonate that acts as a buffer within the stomach. The presence of a fibre mat within the stomach is also a protective and since feeding of forage is slower, there is food material in the stomach that both acts to neutralise stomach acid, as well as preventing acid splash during exercise. Equine Squamous Gastric Disease is a major contributor to poor exercise tolerance with affected horses having a significant reduction in $VO2_{max}$ [16]. Similar studies exploring the effect of glandular pathologies have not been undertaken, but in the author’s experience, are more likely to impact on performance in sports horses. While treatment strategies are beyond the scope of this session, nutritional support for the stomach using supplements is widely reported with considerable evidence for a protective effect by pectin and lecithin containing compounds [17-19]

Muscle diseases

Exertional myopathies are important in the performance horse and may be linked to horses with intrinsic muscle pathology, or may represent muscle pain associated with exertion, especially in the absence of appropriate training. Generally, a reduction in the feeding of non-structural carbohydrates and supplementation with oil is recommended irrespective of the underlyng disorder

Dietary supplementation

A multitude of dietary supplements are available but a lack of well conducted outcomes based studies to document any performance benefits of any of these. That is in part because of the challenges in documenting performance outcomes. Furthermore, trainers often perceive minor benefit, and make decision based on these. Evidence base for some of the more robustly investigated supplements will be discussed.

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NEUROMUSCULAR ELECTRICAL STIMULATION (NMES)

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Definition: *"Neuromuscular electrical stimulation (NMES) involves the use of application of electrical currents to cause muscle contractions, by activation of motor neuron axons or intramuscular axonal branches. It is largely adopted in rehabilitation practice to restore or preserve muscle mass and function, increase muscle relaxation and perfusion, reduce pain, and as a preoperative strengthening intervention ("prehabilitation"). It may also be used to promote voluntary control of muscles in individuals who have lost muscle function due to neurological injury."*

Background

Treating patients with electricity has fascinated humans since antiquity. The electrical discharges were then produced by "electric eels". Luckily, things have evolved and today there are many different types of electrical stimulation such as the well-known NeuroMuscular Electrical Stimulation (NMES) and Transcutaneous Electrical Nerve Stimulation (TENS), as well as the less regularly used Functional Electrical Stimulation (FES), Microcurrent Electrical Nerve Stimulation (MENS), Percutaneous Electrical Nerve Stimulation (PENS), and InterFerential current Therapy (IFT)- to mention a few.

NMES may be divided into two subgroups, Therapeutic electrical stimulation (TES) and Functional electrical stimulation (FES). TES is commonly used by a therapist in a treatment session and is most effective if the patient coordinates muscle contractions with the stimulator. With FES, the stimulation is used in a functionally integrated activity and the stimulator is coordinated with the patients function. New FES devices used on humans can have an EMG synchronised with the FES to aid in the performance of daily activities, such as walking for a person with peroneus paralysis.

NMES equipment

Electrodes: Types, Sizes and Positions

There are two major types of electrodes: carbon rubber and self-adhesive. The latter are not recommended for animals due to problems with the contact between skin and electrode. Electrodes for NMES devices may be inserted transcutaneously or put on the surface.

Electrodes can function as an anode (red) or cathode (black), and in a stimulating device the cathode is the negative pole, because it is the source of negative current (electrons). The recommendations is to position the cathode proximally and the anode distally (*https://www.asnm.org/*).
The size of the electrode affects the current density at skin surface. By increasing electrode size, the current density at the skin surface can be reduced, thereby reducing patient discomfort. However, this effect is relatively smaller at higher fat thicknesses, as is the influence of the inter-electrode distance *(Doheny et al., 2008).*

The positioning of the electrodes is of major importance, since it critically influences the pathway of the spreading current. Stimulation via motor points (MP) involve mostly motor branch excitation, while non-optimal electrode positioning would require higher current levels to excite the motor branch with concomitant greater excitation of pain afferent fibers. A large interindividual variability of the muscle MP location has been shown in humans, influencing the positioning of the electrodes (*Botter et al., 2011; Gobbo et al., 2011, 2014*).

Treatment parameters: Currents and other parameters

There are different types of currents (direct, alternating and pulsed) and waveforms (sine and rectangular/square). However, there are limited objective data available to determine the waveform which provides the maximum muscle strength as well as minimizing pain.

Besides choice of current and waveform one selects other treatment parameters such as Time (treatment time in minutes); Pulse Amplitude (magnitude of current in mA or voltage in V), Pulse duration (width in µsec), Frequency (the number of pulses per unit time in Hz), and Mode (pulse patterns: continuous, bursts, modulated).

Contraindications, adverse effects and limitations (based on human recom.)

Electrical stimulation is contraindicated in the presence of cancer. Do not treat affected skin, a pregnant uterus, an area of thrombophlebitis or thrombosis, over the carotid sinus, or in areas of active haemorrhage. Old/damaged electrodes increases a risk for skin irritation, mild burns, prickling sensation.

Evidence based practicalities of using NMES

NMES is suggested to have three main limitations: 1) discomfort; 2) limited spatial recruitment that results in low evoked tension and early occurrence of fatigue; 3) poor control of dosage (*Gobbo et al., 2014*). Thus the design of the treatment protocol is of utterly importance. The selection of electrodes should be based on the size of the muscle stimulated, and the fact that larger electrode size reduces the amplitude needed to produce the same contraction, thus decreases the risk for discomfort. It is also important to remember that thicker skinfold needs higher amplitudes to produce the same muscle contraction. Further, it has been shown that the most important factors for successful stimulation are not electrode size or stimulation current, but the individual patterns of motor nerve branching (*Lieber & Kelly 1991*). Therefore, a thorough mapping of muscle MP is recommended and muscle length should be the same during MP mapping and during the subsequent NMES session (*Botter et al., 2011; Gobbo et al., 2011, 2014*).

Usually one active electrode is positioned in the proximity to the MP and one distally, suggesting that the same muscle units are repeatedly activated, which increases the risk of muscle fatigue (*Bigland-Ritchie et al., 1979; Binder-Macleod et al., 1993*). It has been suggested that an asynchronous multichannel stimulation delays the occurrence of fatigue with respect to singlechannel synchronous stimulation (*Malesević et al., 2010*).

The waveform of choice might be the sine waveform as it is suggested that sine wave stimulation produced significantly greater muscle strength and significantly less pain than square wave, Russian or interferential stimulation (*Petrofsky et al., 2009; Dantas et al., 2015*). The setting of the other treatment parameters are of course dependent on the purpose of the treatment protocol. It is proposed that strength training with NMES occurs in a similar manner to strengthening with voluntary exercise. However, there are two views regarding the recruitment patterns of muscle fibers. Some research state that the recruitment is a reversal of voluntary recruitment order with a selective augmentation of type II muscle fibers (with a higher specific force). Others suggest that all fibers are recruited simultaneously. Despite the two theories, one knows that stronger contractions are believed to form not only stronger muscles but also induce better and longer lasting pain relief (*Picker et al., 1988; Andersen et al., 1996; Gregory & Bickel 2005*).

Clinical research on horses

No significant differences were observed in the percentage of types I, IIA or IIX fibres, fibre areas, glycogen levels or enzyme activities when comparing stimulated and nonstimulated gluteal and longissimus muscles before and after the NMES treatment in sound horses (*Bergh et al., 2010*). Case studies have shown a reduction in muscle spasm in horses after treatment with FES (*Schils & Turner 2014*). Further, FES is suggested as a safe form of treatment with possible effect on density and distribution of mitochondria (*Ravara et al., 2015; Schils et al., 2015*). Cheetham et al. (2011) have shown positive results when using FES on intrinsic laryngeal muscles during different levels of exercise. Finally, transcranial electrical stimulation has been suggested as a sensitive technique to diagnose spinal injury (*Journee et al., 2018*).

DIAGNOSING CERVICAL PATHOLOGY IN SPORT HORSES

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Introduction

Because of its complex anatomy (1,2) a large variety of clinical manifestations are related to the neck. The precise diagnosis of cervical lesions and the assessment of their clinical significance require a careful clinical examination and the combination of different imaging techniques.

Clinical manifestations associated to cervical vertebral lesions

Ataxia has often been considered as the main manifestation correlated to cervical spine abnormalities and little attention has been paid to other clinical manifestations (3,4,5). Lesions of the cervical spine can be responsible for neck pain, neck stiffness, poor performance, forelimb lameness and, in some cases, for peripheral or central neurological manifestations.

Physical examination

Muscle atrophy of the dorsal cervical muscles is commonly associated to chronic neck pain. This is mainly visible over the splenius and semispinalis capitis muscle location, between the vertebral axis and rhomboideus cervicis muscle. Limited or asymmetrical active neck lateroflexion can be observed. In a limited number of cases palpation can revealed a thickening over one or several articular process joint(s). When a forelimb lameness is present, foot atrophy with high heels can be seen on the side of the lame limb which is often positioned in retraction while standing.

Dynamic examination

At the walk on a 8 figure manifestations include neck stiffness, reduction of the cranial phase of the stride and neurological symptoms of dyskinesia (such as hypermetria or hypometria) on one or both forelimb(s). At the trot on a hard surface in straight line, head and neck motion may be reduced (especially at the base of the neck) and this induce also some thoracic stiffness. A forelimb (and sometimes an ipsilateral hind limb lameness) can be seen; it typically shows up as a reduction of the cranial phase of the stride and defect of fetlock extension during the stance phase. Athletic manifestations when the horse is at training or competing include abnormal neck carriage, asymmetry on turns (left/right), difficulties in changing leads and manifestations of back pain (thoracolumbar stiffness, bucking, kicking…).

Diagnostic imaging of cervical lesions

Diagnostic imaging of the equine neck lesions is routinely based on 3 complementary techniques: radiography, ultrasonography and nuclear scintigraphy. Some MRI machines enable imaging of parts of the neck and CT scan machines with wide opening permit examination of most of the cervical spine in adult horses under general anesthesia (6-8).

1. Radiography

Radiography remains the basic imaging technique for the evaluation of the cervical spine. Our routine approach consists in making 3 laterolateral projections including: the cranial part from the external occipital protuberance to the third cervical vertebra (C3); the intermediate part from C3 to C6, and the caudal part from C5 to the first (T1) and second thoracic vertebra (T2). Good superimposition of the left and right sides of the vertebra is crucial. Any rotation or oblique projection alters the evaluation of the size and shape of the articular processes, symphyses and vertebral canal. The caudal projection (C5-T2) must be exposed enough to allow good visualisation of the last cervical disc (between C7 and T1). Forty degree oblique dorsolateral-ventrolateral projections are useful to evaluate separately the left and right articular processes. A good knowledge of radiographic anatomy and its variations is essential to assess carefully the presence of findings and avoid misinterpretation (9-11).

The radiographic criteria in relation with the presence of neck lesions are well known; they include: the vertebral alignement, the size and shape of the vertebral canal, the size, shape and architecture of the articular processes, the bone density of the vertebral pedicule, the thickeness of the intervertebral disc as well as shape of the vertebral fossa and corresponding vertebral head.

2- Ultrasonography

Ultrasonography is systematically used in association with radiography in the routine evaluation of neck problems in horses (5). It is performed with 7.5 or 5 MHz convex probes. It is very sensitive to any bone surface abnormalities such as hypertrophy or fragmentation of the articular processes. Besides, soft issue injuries of the synovial intervertebral joint space between the caudal and cranial articular processes (synovial fluid effusion, synovial membrane proliferation, capsulitis…) can be identified.

3- Nuclear scintigraphy

When available and indicated, nuclear scintigraphic examination of the neck is performed on both left and right sides from the cranium to the scapulae. Additional ventral views are made to establish significance or location of findings over the vertebral body axis. Asymmetrical or symmetrical increase capture of radiation over the articular processes can be related to hypertrophy and bone remodelling; increase capture over the vertebral symphysis (including vertebral fossa and adjacent head) is usually not associated to radiographic changes.

4- Advanced cross-sectional imaging

Providing 3D representation of normal and abnormal anatomical structures, as well as imaging of the soft tissues inside the vertebral canal and intervertebral foramina, magnetic resonance imaging and computed tomography, with and without contrast, improve tremendously the diagnosis of cervical lesions.

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EXERCISE TESTING AND MONITORING TRAINING PROGRESS IN WARMBLOOD SPORT HORSES

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Introduction

In human and equestrian sports performing standardised exercise tests (SETs) and monitoring daily training practices can help athletes, coaches and trainers to plan, and evaluate and optimize their training process (Soligard et al., 2016; Munsters et al., 2014). Due to the increase in tracking technology, more and more wearables are and will become available for the equestrian industry. What lessons can we learn from human sport science? And what is valuable and practical to get more insight in the fitness and daily training practices of our Warmblood sport horses?

Exercise testing in Warmblood sport horses

Training in equine sports is largely based on experience and intuition. Training should prepare the horses properly for competition by inducing the physiological adaptations necessary to perform at a high level. Standardised exercise tests (SETs) can help in understanding when a horse is 'fit to compete', to assess poor performance, to compare horses' fitness indices or to monitor training progress. Besides standardisation, repeatability and sensitivity of an SET, exercise tests should be valid, meaning that it will simulates the demands of the specific sport discipline. Field SETs allow horses to be tested under their normal performance circumstances and is therefore more beneficial than treadmill testing in Warmblood sport horses. In addition, a field SET can incorporate the technical skills required in these disciplines. A field SET typically consists of several incremental bouts of exercise during which, heart rate (HR), plasma lactate concentration (LA), and the velocity are measured.

In event horses, a simple four step incremental exercise test is most often used, in which HR, LA and velocity are measured as outcome parameters (Munoz et al., 1998; Munsters et al., 2013). In dressage and riding horses a wide variety of exercise tests has been developed, including incremental exercise tests, ridden indoor tests and lunging tests (Harris et al., 2007; Sloet et al.,1991; Van Erck Westegren, 2014). In show jumping, a combination of incremental exercise tests in the field are used together with more technical jumping tests (Munk et al.,2013; Sloet et al., 2006).

Monitoring training sessions in sport horses

Training regimes vary greatly between disciplines, horses and trainers and even within the same discipline and at the same level (Egenvall et al., 2013; Serrano et al., 2002). As exercise testing can help in determining the current fitness level of a horse and help to establish a more optimal training programme, it is of great value to monitor horses also throughout their training sessions. Changes in LA response to exercise in a horse can reflect changes in fitness over time (Davie and Evans, 2000). In event horses, fitness improvement could be seen by evaluating each individual horse's HR and belonging speeds during their normal conditional training sessions (Munsters et al., 2013). Besides evaluating alternations in fitness, it is also important to evaluate whether a horse is showing its normal response to a specific type of training. Previous research has shown that HR measured during conditional training sessions in eventing horses have predictive value for pending injuries (Erickson et al., 1987; Munsters et al., 2013).

In the Olympic disciplines around one third of all training day losses and wastage of horses are caused by musculoskeletal injuries (Murray et al., 2010; Sloet et al, 2010). Several studies have been performed investigating the relation between workload and injuries (Egenvall et al., 2013; Murray et al., 2010; Munsters et al., 2013). However, data about actual workload performed by sport horses and measures to determine this workload accurately are limited. Recently, in all kind of human sport disciplines, more and more evidence is arising that the rate of change of applied load and the load history, or fitness of the athlete, has to be taken into account (Soligrad et al., 2016). Munsters et al. (2018) showed for the first time that in elite event horses, peaks in workload were significantly associated with an increased risk in injury. Therefore, workload monitoring can be used to evaluate training programs of sport horses and help to determine whether horses are well prepared for the physical demands of a competition.

In conclusion, the controlled use of exercise tests in field conditions and the assessment of training sessions will improve training strategy and prepare horses better for competition. This will have a direct positive effect on the welfare of the sport horse in training and competition and on the safety of both horse and rider.

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THE WHAT AND WHO OF IMAGING FINDINGS WITHOUT CLINICAL SIGNIFICANCE

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Introduction

The number and sensitivity of imaging techniques used for the diagnosis of musculoskeletal injuries in small and large animals are growing exponentially. In the human literature it is well known that incidental findings may be identified in asymptomatic patients and athletes (1-4). In equine imaging there is still a lack of information on anatomical variations (5) and incidental imaging findings or artefacts to help for interpretation of images provided by the different modalities available nowadays. This could explain why the list of findings written in imaging reports is expanding so that no more horses are exempt of injuries and some of them seems definitively handicapped. Even when a single area is examined multiple different findings are listed in such a way that the lesion responsible for the problem of the horse is difficult to discriminate from incidental findings. Fortunately, horses do not adhere to imaging reports and often continue their sport or racing activities with or without treatments, neglecting the conclusions of veterinary reports and prognosis.

Purpose

The presentation will consist in showing incidental or significant imaging findings identified on asymptomatic sport and race horses or on horses performing adequately at different athletic levels. It is also to stress the need of a precise clinical examination as well as a careful assessment of the horse athletic capacities which in most situations are more relevant than imaging findings.

The real significance of a finding must not be established considering the number of horses affected but more importantly, must take in consideration the number of horses presenting this finding asymptomatically and/or able to achieve their expected use including high athletic careers.

Discussion - Conclusion:

In the past, clinical examination used to be essential because of the lack of adequate imaging modalities to identify the cause of the horse problems; now clinical examination remains critical to filter what is really significant and eliminate all findings contaminating image interpretation. This is especially critical for diagnostic purposes when examining and managing clinical cases, but also essential when assessing treatment modalities applied to incidental or artefactual findings. The conclusions of pre-purchase examination also are affected generating tremendous frustration for sellers and buyers.

Besides the necessary documentation for characterizing anatomical data and variations (5, 6), artefacts and incidental findings, there is a need for longitudinal studies to demonstrate clinical and athletic relevance or tolerance of true findings (7).

The goal of the presentation is to attract attention on new diseases of the present and future times: overinterpretation, long, complex and puzzling diagnosis as well as the associated excessive medication of asymptomatic horses.

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SPINAL BIOMECHANICS AND MUSCLE ACTIVITY DURING EQUINE LOCOMOTION

Theresia Licka

Sorry, No abstract provided…

VIDEOGRAPHIC AND KINETIC TECHNIQUES IN HORSES UNDER FIELD CONDITIONS

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Classically, the first step for the assessment of the locomotor system has been the Subjective Visual Inspection. This procedure, when used for lameness detection or the evaluation of dynamic characteristics have big limitations; the most important is because is subjective, existing a big inter-observer variation when observers have different levels of experience. This fact acquires a special relevance when a treatment is applied to a lame horse, and we want to obtain reliable data concerning level of efficacy and its duration.

To solve this limitation, biomechanical techniques started to be used, although in first instance, only with research purposes. However, one of the main limitations of these system is the high cost in terms of time, but overall in economic cost.

In kinetics, for biomechanical motion analysis, the main parameter is the GRFs, specially the PVF and VI. The PVF could also be measured in standing position, if individual limbs are placed in different, sincronized devices, makin posible to perform postural (balance) exams.

How can the posturography help to lameness detection? Because the support with a lame, painful limb causes adaptive postural balance changes, with consequent constant corrective actions of the balance control system, and then COP pathway modifications which can be recorded.

Regarding kinematic exam, the current techniques are fully automatized, recording data and analyzing them in a few seconds. Examples of this are the videography, the electrogoniometry and also the inertial sensors. Perhaps the videography is the most widespread kinematic technique. With this procedure, we can obtain angular, linear and temporal data as angles of flexion/extension, distances as stride length, or times as duration of the support phase, stride frequency, etc.

At this point we have to question if could low-cost biomechanics be performed.

The answer is yes, but with limitations and conditions.

1) Reliability and replicability.
2) Reproducibility, given that the controls, the references don´t exist. The reference is the own animal.
3) As the work of recording and analyzing data will be manual, time and effort is required.

As said above, one of the big limitations is the lack of a control group for comparisons, its the own subject that should be compared with itself. In this kind of studies, the most suitable procedure should be the symmetry measurements, given that we precedently stated that a lame animal becomes asymmetric shifting, preferently (but not exclusively) the weight towards the opposite side. Then we can use this formula with force o pressure values.

$$\Delta\% = 200*(CL-LL)/(CL+LL)$$

In this way, a recovering animal should decrease its value in this formula and coming near to 0. That is to say the animal is becoming more symmetric.

With this aim, some authors propose the use of kinetic platforms, which are complements of some video game-based consoles. Other authors show how force platform can be purpose-built.

On the other hand, videographic measurements of kinematic (angular, temporal, linear) parameters can be performed by means of the use of free manual or semi automatized software.

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SHOCKWAVE TREATMENT OF SACROILIAC PROBLEMS IN HORSES

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Sacroiliac disease: Sacroiliac (SI) disease in horses is a relatively new field of scientific study, having only been recently (last decades) described in literature. The SI joint serves as a major point of weight and force transfer between the hindlimb and the vertebral column as the leg takes weight during the stance phase of the stride. Injuries to the SI joint region can be classified into 2 major categories: primary SI injury where pain is caused by a direct trauma to the area (e.g. fall inducing ligament injury or sprain or fracture near the SI joint) and secondary SI injury where the horse develops SI joint disease secondary to lameness in the hindlimb or the back.

Clinical signs & Diagnosis: Clinical signs exhibited by horses with SI disease include poor performance, low-grade, sometimes intermittent and/or shifting hindlimb lameness, a “bunny-hopping” gait, shortened hindlimb stride, hind quarter asymmetry, back soreness, sensitivity to regional palpation / sacroiliac stress tests and behavioral alterations. The horse lacks impulsion from behind and the loss of hindlimb propulsion often feels worse to the rider than it may look from the ground. Muscle loss over the rump and the increased prominence of the tuber sacrale (known as "hunter’s bump", and which is not a specific sign of SI disease) are frequent. SI joint diagnostic analgesia is possible, but non-specific, and it represents a risk of the horse being unable to bear weight on the leg until the block wears off.
Diagnosing SI disease can be challenging and is usually based on exclusions of other causes of poor performance, hindlimb lameness and back pain, as many horses suffering from SI disease are often concurrently affected by other musculoskeletal problems**.** Ultrasound examination of the joint (from the outside/dorsal surface and from the inside/ventral aspect by rectal examination) is useful in examining SI ligaments and joint contour at the bottom edge of the joint. Because of its location and the heavy surrounding musculature, X-rays of the joint cannot be obtained. However nuclear scintigraphy can provide invaluable information about bone remodeling and inflammation in the SI joint region. Ultrasonography and scintigraphy can provide additional information in some horses, however negative results do not preclude SI pain.

Treatment of sacroiliac disease: If the diagnosis is inaccurate, so is the treatment. Treatment and management of SI disease can be classified into different categories. 1: Secondary SI pain: treatment of the underlying lameness in the lower limb (e.g. proximal suspensory desmitis) is mandatory in managing the source of SI problems. 2: Acute desmitis and SI instability: pain relief and 2 to 3 months rest may be indicated. 3: Chronic cases: developing and restoring muscular support to the area is often key in managing pain and instability in this region. Several SI treatments modalities are available: **a.** SI joint injection (ultrasound-guided) with steroids is helpful in providing pain relief. However medication generally provides relatively short-term relief and must be followed up with strengthening exercises in order to optimise long-term benefits; **b:** Systemic anti-inflammatory medication is helpful in providing pain relief; **c:** Rest and rehabilitation program; **d:** Extracorporeal Shockwave therapy (see below); **e:** Chiropractic techniques may be helpful in chronic cases to restore normal, pain-free joint mobility; f**:** Others: Acupuncture, etc.

Shockwave treatment of sacroiliac problems:

1. *Physical principles of shockwaves:*
   Therapeutic shockwaves are high intensity pulses of mechanical energy similar to sound waves generated by an electromagnetic coil or a spark in water. This mechanical energy was adapted in the late 1970 for medical use. Through the 80s its use focused on lithotripsy and a non-invasive method of treatment of renal calculi, giving origin to what we term Extracorporeal shockwave therapy (ESWT). ESWT uses high peak pressure (5-150 MPa and a broad frequency of 1 Hz-100 MHz). These energy bursts are characterized by very short (<10 ns) high peak pressure amplitude. Harnessing this energy and using it directly in tissues (and not only as a lithotriptic agent) has been the focus of much work since the 80s. Precise characterization of the mechanism-of-action of ESWT has not yet been established. The biological logic behind this therapeutic use resides on the principles of mechanotransduction by which mechanical stimuli are converted into electrochemical activity by cells leading to activation of metabolic processes within them. It is important however that each of these reaction is finely tuned and energy and frequency being specific. Therefore mechanical stimuli for a particular effect in a specific tissue is not an easy task as current knowledge about these properties is scarce. However, neovascularisation, bone remodeling and fibroblast stimulation have been shown to occur following the use of ESWT. Another proposed mechanism of action involves the finding that these mechanical stimuli lead to tissue damage (microfracturing bone and damaging tendon cell). The resulting inflammation and subsequent healing process is then used to trigger healing. A third mechanism of action is a local analgesic effect, and appears to occur after the use of ESWT. ESWT diminishes pain through what is known as hyperstimulation anesthesia. This is where the nerves sending signals of pain to the brain are stimulated so much that their activity diminishes, thereby decreasing or eliminating pain. This effect is usually, but not always, short lived. These 3 mechanisms of action might occur simultaneously or at different time points after treatment. Nevertheless, much of the use and settings are empirical and based on poor or little evidence.

2. *Focused or radial (pressure wave) shockwaves:*
   The shockwave machines are all based on one of the following technologies: Electrohydraulic, electromagnetic, radial pressure and piezoelectric. Electrohydraulic, electromagnetic and piezoelectric technologies are true forms of ESWT. They differ in the way in which they can be controlled and focused, their depth and intensity adjusted. The radial shockwaves are different from the others, are not considered true extracorporeal shockwaves, but rather a pressure wave therapy. True focused shockwaves are very short and very intense; while radial pressure waves are slower, less intense, elongated and more sinusoidal in appearance. Consequently, radial shockwave technology is not considered a shockwave technology, but pressure wave technology.
3. *Clinical experience with shockwave treatment of SI problems in horses:*
   In humans, very encouraging results of treatment of SI pain using ESWT were recently reported. However, to our knowledge, no similar study has been reported in horses. Since 2015, the author has been using a chiropractic test to diagnose SI pain in horses. This test seems reliable when compared to the classical clinical and imaging diagnosis of SI problems. The author have experienced focused and radial shockwaves to treat SI problems in horses. In 124 horses, SI disease was diagnosed based on a chiropractic test. There were jumping (n: 45; 5 to

15 y) and flat racing horses (n: 79; 3 to 6 y). Horses were treated using focused (n: 50) or radial (n: 74) ESWT with the following protocols (Table 1).

Table 1: Treatment protocols of ESWT for SI disease.

ESWT (Technology)	Treatment windows	Probe / Transmitter	Energy /shocks per window	Treatment interval
Focused	Craniomedial & Dorsal	Power probe (High energy)	-Energy: E11 (max E12) - Frequency: 240/min - Shocks: 500 to 800	2 treatments at 1 week interval
Radial (pressure)	Craniomedial & Dorsal	Deep Impact transmitter	-Pressure: 4 bar -Frequency: 5 Hz -Shocks: 1000 to 1500	2 treatments at 1 week interval

Follow up to determine the response to treatments was achieved using SI chiropractic test and hindlimb lameness examination. Rehabilitation program consisted of 10 minutes hand walking, twice daily, between the treatments, then 2 weeks following the treatments. Short term follow up showed that 106 horses (85.5%) were lame free and returned to full exercise; 18 horses (14.5%) have improved then showed recurrence of the disease. The author couldn't notice any difference between the effect of focused or radial ESWT. No long term follow up of the horses has been carried out.

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BACK-PAIN: AN INTERNATIONAL PERSPECTIVE

B. Riccio

Back-pain is a common cause of poor performance in sport horses. Clinical signs of back-pain can be extremely variable and the steps followed by the clinicians during the evaluation of the horses with suspected back-pain are different. Because the diagnostic workflow and the therapeutic approach are rarely similar in european equine practices, we performed a first study in 2006 to evaluate how different was, in Europe, the approach of equine veterinarians to back pain syndrome. A second survey have been done in 2016 to assess the evolution in the medical approach to diagnose and manage back- pain over a 10 years period. To investigate this topic, two cross-sectional surveys were addressed to equine veterinarians working in practice throughout Europe ten years apart (2006-2016). The preliminary survey was conducted in 2006, containing 10 multiple-choice questions organized in a progressive order. The second survey was designed in 2016, sending a link for a web-based survey by email (Surveymonkey.com, Portland, Oregon). Additional questions were added in the 2016 questionnaire including 16 questions in total. In both cases, questions were translated into three different languages (English, French and Italian) in order to reduce possible misunderstanding due to text interpretation. In the first part of the survey, questions were focused on the veterinary surgeon's personal and professional information, including nationality, breed and use of the horses most commonly treated. The respondents background was investigated, asking them the number of horses examined for musculoskeletal diseases every month, the clinical signs considered suggestive for back- pain and their specific methods used to detect back-pain during clinical examination. Further questions were focused on diagnostic methods adopted and therapies. Incomplete responses and incomplete surveys were excluded from the analysis. The answers were organized in an Excel dataset and analysed using chi-squared or exact Fisher test.

There were 47 respondents in 2006 and 168 in 2016, from 8 European Countries. Primary back disorders were rarely encountered. The main reasons for examining horses with back-pain were poor performance (76%), behavioural issues (68%) and lameness (50%). When assessing back pain, 97% of respondents applied careful digital pressure over paravertebral muscles, 90% of them used digital back mobilization and 69% was detecting areas of localised heat.

Clinical tests	2016 Respondents *n* (%)			2006 Respondents *n* (%)		
	Always	Sometimes used	Never used	Always	Sometimes used	Never used
Back mobilization	**151 (90)**	12 (7)	5 (3)	**40 (85)**	7 (15)	0 (0)
Diagnostic analgesia	8 (5)	57 (34)	**102 (61)**	0 (0)	**47 (100)**	0 (0)
Evaluation of saddle	**76 (45)**	**82 (49)**	10 (6)	n.r.	n.r.	n.r.
Local heat areas	**116 (69)**	25 (15)	25 (15)	**28 (60)**	13 (27)	6 (13)
Local thickening of supraspinous ligament	40 (24)	**64 (38)**	**64 (38)**	**31 (65)**	12 (26)	4 (9)
Neurological examination	32 (19)	**118 (70)**	18 (11)	0 (0)	**47 (100)**	0 (0)
Oral examination	52 (31)	**89 (53)**	27 (16)	n.r.	n.r.	n.r.
Paraspinal muscles digital pressure	**163 (97)**	2 (1)	3 (2)	**46 (98)**	1 (2)	0 (0)
Rectal examination	13 (8)	**101 (60)**	54 (32)	10 (21)	**31 (66)**	6 (13)
Ridden exercise evaluation	10 (6)	**118 (70)**	40 (24)	**39 (82)**	8 (18)	0 (0)
Surcingle test	34 (20)	**71 (42)**	**64 (38)**	**41 (87)**	6 (13)	0 (0)

n.r., not required. Frequently reported percentage (>35%) are given on bold font.

Radiography and ultrasonography were the most frequent diagnostic imaging modalities used to investigate the causes of back-pain in both surveys. Corticosteroids injections were used for local treatments by 80% of respondents in 2006 and 92% in 2016. In the last survey ultrasonography was extensively used during the injections of the vertebral articular processes and sacroiliac joints region. The use of complementary therapies was restricted to a low percentage of respondents in the first survey (20%) but it increased over the decade. In 2016, a wider percentage of respondents considered osteopathy (40%), kinesiotherapy (29%) and acupuncture (22%) when treating back disorders compared to 2006. Obtaining a definitive diagnosis in horses with back-pain is considered challenging due to the reduced accessibility to the area and the variability in the manifestations of pain. The treatment recommended is often symptomatic, but the increased use of alternative therapies reflects the current multimodal approach and the increased attention to rehabilitation techniques. Although just few countries were included in the investigations, the study represents a useful portrait of the European trends over the last decade, in light of the number of veterinary hospitals participating to it.

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BREED DIFFERENCES AFFECTING FUNCTION AND PERFORMANCE: THE KEY TO THE HOLY GRAIL ?

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The effects of breed conformation on athletic function and performance has been the subject of many studies, which are mostly based on subjective, anecdotal evidence and experience of the observer (Van Weeren and Crevier–Denoix 2006). Some people would consider this an "art form" in which some people have a natural talent for assessing the influence of different breed and conformational characteristics on actual talent and injury risk. Nonetheless, objective conformational parameters have been developed and were used to assess various breed and conformational traits on function and performance (Back et al. 1996, Holmström and Back 2013, Rossdale and Butterfield 2006). The goal of this review is to highlight some of the work that has been done in this area, as well as emerging evidence that may lead to further objective characterization of subtle breed and conformational traits (Verkade et al. 2017). Within the last couple of years a few classical studies have emerged relating conformational traits and injury, both for the racing Thoroughbred, as well as the sporting Warmblood horse.

For the Thoroughbred was mainly focused on the carpus as this anatomical location is proned for injuries dealing with chip fractures as well as the fetlock for condylar fractures. Anderson and McIlwraith (2004) showed that only 5%-7% of long bone growth occurred between weaning and the 3-year-old year and therefore most bone growth is completed by a year of age. Anderson et al. (2004) also compared conformation to injury in Thoroughbreds. They found that carpal valgus characteristics were somewhat protective. Those horses with carpal valgus tended to have decreased carpal effusion, decreased carpal fractures, decreased carpal physeal reaction and decreased fracture incidence in the right forelimb. Those horses that were considered "over at the knee" had increased chance of phalangeal fractures and increased fetlock physitis. Those horses with "off-set knees" tended to have increased right front fetlock effusion and increased right front fetlock problems in general. These differences occurred even in the face of the fact that Thoroughbreds tend to have a high incidence of front fetlock problems anyway.

Therefore, today most clinicians feel that mild carpal valgus is protective and is normal during growth. Similarly to the results of Barr et al. (1994), they did not observe that being "back at the knee" was an issue. However, Back et al. (1996) noticed in warmbloods a relationship indeed between a back at the knee conformation at square stance and carpal hyperextension at trot. Conformation has its influence on soundness at speed performance, but also seems to have an effect in warmblood horses bred for sports performance, dressage and jumping. The majority of lamenesses is in the distal forelimb, which is a reason in warmbloods to have a closer look at hoof conformation in relation to performance and injuries.

For the Warmblood, the “grassfoot” phenomenon has been unraveled, as foals with relatively longer limbs and shorter neck and head length seem to have a preference in forelimb position when grazing leading to an asymmetrical development of their front feet, the so-called uneven feet (Ducro et al. 2009a). The steep foot is the positioned backwards and the sloping foot is put forward. Warmblood studbooks tend to select their horses in not having this asymmetry. The effect of this phenomenon has been evaluated at a population level comparing studbook admission data, scoring the existence of uneven feet, with what horses have delivered in sports (Ducro et al. 2009b). It appeared that the length of competitive life was shorter for jumping than for dressage. A different set of risk factors was found for each level and discipline: e.g. height at withers was a risk factor at basic level in dressage and jumping, while pastern angle was a risk factor at the elite level of jumping and dressage. The trait ‘uneven feet’ tended to shorten the competitive life in dressage but was a significant risk factor at the elite level of jumping.

Subjective evaluation makes statistical analysis difficult and often leads to lack of robustness in data analysis. Therefore, people more and more are routinely using objective techniques, like photographic (Anderson et al. (2004), videographic (Weller et al. 2006), passive marker (Serra Bragança et al. 2017, Back et al. 2019), and active inertial sensor technology (Barrey et al. 2002, Bosch et al. 2018) to objectively evaluate locomotion in relation to breed conformation (Fig. 1,2).

Although reducing the incidence of injury is of great importance to the industry, these analysis techniques can also be used to compare breed conformational parameters to performance. To date, it is the best that the veterinarian can do, is offer visual counseling on the physical characteristics of an animal in order to reduce injury and possibly maximize performance potential, assisted by modern objective measurement techniques.

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Figure 1. Photographical illustration of a horse equipped for a multi-camera based gait analysis system (Qhorse®).

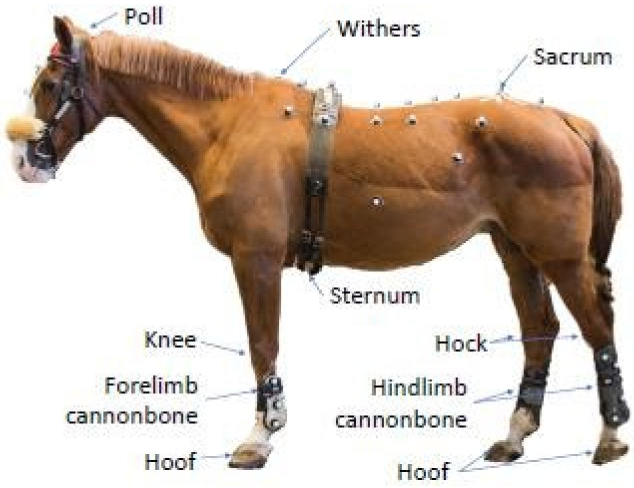

Figure 2. Photographical illustration of a horse equipped for a multi-sensor based gait analysis system (EquiMoves®).

BIOMECHANICAL DIFFERENCES BETWEEN TREADMILL AND OVER-GROUND LOCOMOTION

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In the early eighties Ingvar Fredricson and Stig Drevemo from Uppsala University introduced the first motor driven treadmill (TM) in equine locomotor research. Already at that time, big efforts were made to imitate the footing properties of the over-ground situation (OG) by using a coco mat instead of a rubber treadmill belt to mimic the slip of the hoof at first ground contact. Since then, equine TMs are increasingly used in training, for sports medicine diagnostics, rehabilitation, and in research. However, the question, how far biomechanical and physiological parameters measured on the TM are comparable to the OG situation remains somehow unclear and is a frequent subject of discussions in the scientific community.

Early studies comparing the two situations indeed found marked differences e.g. in heart rate and lactate response or stride characteristics (Barrey *et al.*, 1991; Valette *et al.*, 1992; Couroucé *et al.*, 1999) concluding that results of TM studies should not be generalized to the OG situation. To some degree, these observed differences certainly originated from the direct comparison of ridden horses or horses pulling a sulky with horses moving freely on the TM. From these studies a 3.0-3.7% TM incline for Warmblood riding horses (Barrey *et al.*, 1993; Galloux *et al.*, 1993) and a 2.4% incline for trotters (Couroucé *et al.*, 2000), or a +10% speed correction (Sloet van Oldruitenborgh-Oosterbaan and Barneveld, 1995) were proposed to correct for the “treadmill effect”.

Studies where both situations (OG and TM) were investigated in either ridden (Sloet van Oldruitenborgh-Oosterbaan and Barneveld, 1995) or unridden horses (Buchner *et al.*, 1994a) revealed that horses on the TM generally showed lower heartrate and lactate values, increased stride and forelimb stance durations, and larger fore- and hindlimb retraction angles when compared to the OG situation at similar speed. At trot, various studies reported a negative time of advanced placement on the TM, meaning the forelimb touches the ground before the diagonal hindlimb (Buchner *et al.*, 1994a; Weishaupt *et al.*, 2004; Weishaupt *et al.*, 2010). The experimental design chosen by Buchner *et al.* (1994a) also allowed to compare gait differences between two OG conditions: rubber surface (same as on the TM) and asphalt. Interestingly, stride duration differed more between surface types than between TM and OG, indicating that certain differences in the motion pattern are likely to be caused by the surface properties.

A completely other conclusion was drawn by Van Ingen Schenau. He applied a theoretical approach to investigate possible differences in kinetic and potential energy between TM and OG (van Ingen Schenau, 1980) and concluded that using a fixed coordinate system would result in the faulty assumption that the two conditions are differing. As long as air resistance is neglected, TM belt speed is constant, and the coordinate system relates to the moving belt, no mechanical difference exists between OG and TM locomotion. He therefore postulated that all differences found in locomotion patterns would originate from other than mechanical causes.

That said, habituating horses thoroughly to the TM is decisive. Depending on gait (walk, trot), 2-4 habituation sessions are recommended to consolidate the motion pattern and to stabilise the key gait parameters of lameness quantification, e.g. peak vertical forces (Buchner *et al.*, 1994b; Bächi *et al.*, 2018). Bächi *et al.* (2018) reported a plateauing of heartrate within the same number of habituation sessions indicating that the mental state of the horse contributes to the variation of the movement pattern in a specific gait.

It is a fact that biomechanical and physiological results generated on a treadmill cannot be directly transferred to the field situation. Furthermore, horses need to be habituated to the TM, the movement repertoire is limited to straight-line and uphill locomotion, and it offers only limited proprioceptive challenge. In orthopaedic patients, this might be a drawback at certain stages of the rehabilitation process. However, the TM also has outstanding properties, which favours its use in research and clinical settings. The potential to standardise and reproduce exercise intensity (speed, incline), surface properties and condition is crucial in research but also in the clinical use when biomechanical or physiological variables need to be measured repeatedly at different time points or after intervention (e.g. diagnostic anaesthesia). The stationary situation offers more possibilities to instrument the horse or apply technical modalities to measure physiological parameters and locomotion function, and it allows direct tactile stimuli during rehabilitation training e.g. to induce a correct posture. Once habituated to the treadmill, horses are often relaxed and focused, which markedly reduces the inter-stride variability and improves data quality. These advantages and disadvantages need to be considered carefully in order to decide whether or not to apply equine treadmills in scientific research or in clinics for diagnostic purpose.

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INJURIES AND REHABILITATION IN STANDARDBRED RACEHORSES

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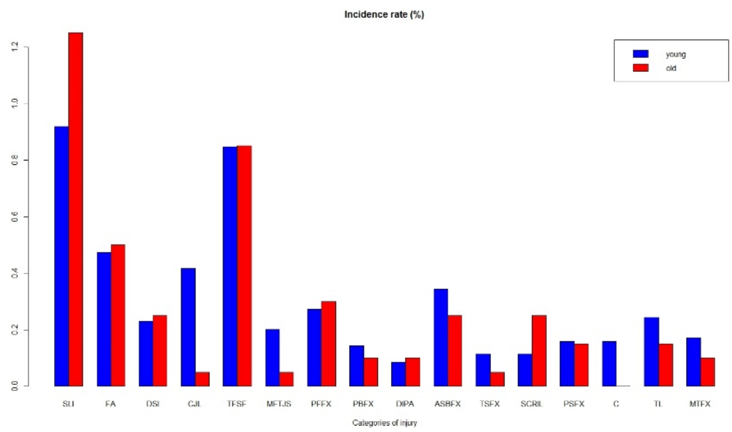
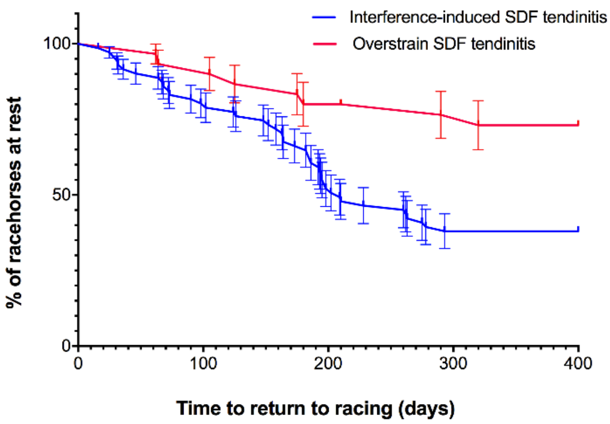
Harness racing is a popular racehorse discipline, developed in the late 18th century, from a traditional recreational activity, in which horses race at a specific gait (trot) and they pull a two-wheeled cart called *sulky*. Large-scale studies on exercise-related musculoskeletal injuries (MSIs) in Standardbred racehorses (STBRs) are missing, compared to Thoroughbred racehorse (TBRs), because catastrophic events are rare in competitions. Nevertheless, exercise related MSIs are the primary cause of reduced training days and racehorse wastage in STBRs, raising welfare concerns on racehorses' safety. Standardbred racehorses reached elevated speed in racing adopting "flying trot", a unique gait in which hindlimbs overstep the forelimbs laterally to sustain a long stride length, with limited vertical oscillation of the centre of mass, lateral oscillation of the body, and reduced impact generated in front legs during the stance phase of the stride in comparison to gallop. This unique gait is characterized by the storage of elastic energy into the collagenous tissues of the suspensory ligaments (SL) and flexor tendons rather than along the spine, gluteal and hamstring muscles observed at gallop.

Recently, our study on STBRs characterized injuries rate of exercise-related MSIs, defining sixteen categories of trauma based on their aetiology, repetition and anatomical localisation in a population of 356 racehorses, contributing 8961 months at risk. The overall exercise-related injury rate (IR) was 4.79 per 100 horse months; SL desmitis was the most common injury observed in this study, followed by superficial digital flexor tendon (SDFT) lesions (*Figure 1*).

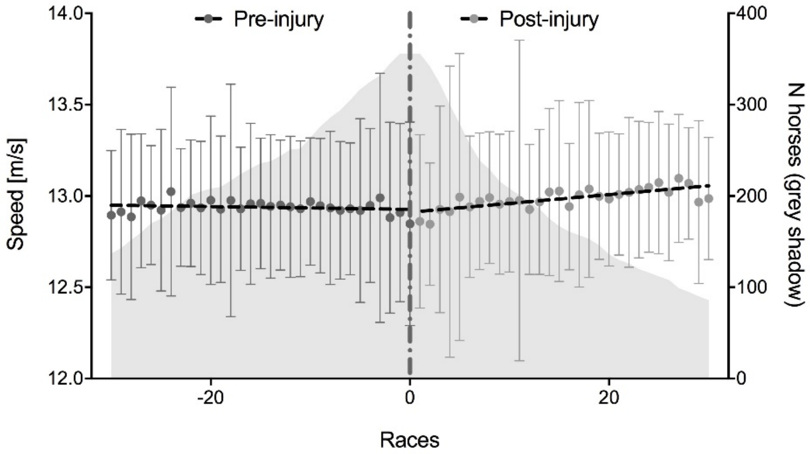


Considering risk factors, animals receiving medical treatments (meaning intra-articular medications) showed a 2.6-fold increased risk compared to others to sustain a MSI in the 30 days following medication, not necessarily within the same location of treatment. Our results regarding the variable racing intensity variable show that the IRs of MSIs decrease as the number of races increases. An high value of IR of MSIs was observed for the lowest level of variable racing speed, i.e. "not-qualified STBR" (IR = 10.29). The IR decreases progressively from this lowest level to the upper classes of "elite-STBRs" (IR = 3.65) and "top level-STBRs" (IR = 3.89).

SDFT lesion shows an atypical asymmetrical position at the margin of the cross-sectional area of the tendon. This is an important difference in comparison to TBRs, and their typical "core lesions". Recently we identified interference injuries to the palmar aspect of forelimbs in STBRs as a cause of traumatic tendonitis of the SDFT. STBRs with gait penalties identified during the race and racing with unshod hind feet had an increased risk of interference injuries (OR 11.13 and OR 6.26, respectively). Interference-induced tendonitis cases had a shorter time to return to racing than overstrain-induced tendonitis (*Figure 2*).



Considering the return to racing after injuries, a retrospective single open cohort study was performed to report recovery time, retirement rate, and racing performance after recovery of MSIs. In our study, the median recovery time after the first injury in the athletic career of STBRs was 156 days (IQR: 145, 178) and retirement rate after their first MSI was 27.4% (95%CL: 20.1, 29.0). Considering the second injury in their racing career, 57.2% of injured racehorses retired (95%CL: 48.5, 65.6). The hazard ratio (HR) to return in activity after the first *vs.* second injury events was 3.9 (95% CL: 2.9, 5.4; cox regression p<0.0001). The classes of MSIs with the numerically highest percentage of retirement in our study were SDFT lesions and SL desmitis; we observed a retirement rate (=fraction of racehorses at rest) after SL injury of 37.1% (95% CL: 27.1, 48), whereas after SDFT lesions we had 63.2% (95% CL: 51.3, 73.9) considering 700 days post-MSIs. The HR for return in training after SDFT lesion *vs* SL injury is 0.39 (95% CL 0.26-0.58; cox regression: P<0.0001). We studied a total of 12990 races contributed to calculation of the performance rating of the entire cohort of STBRs over a long observation period. Racing speed was constant during 30 races before MSIs (slope value, 95% CL: -0.0007, -0.0022, 0.0006; non significant deviation from 0; P=0.03), while it gradually increased over 30 races after MSIs, after the corresponding recovery time (slope value, 95% CL: 0.0048, 0.0031, 0.0065; significant deviation from 0; P<0.0001). However, when the racing speed pre- and post-MSIs was studied solely on the horses that completed all 30 races post-injury, it was not observed an increased racing speed post-injury. The number of races completed by STBRs increased constantly during 30 races before the injury and it progressively decreases over 30 races following MSIs, meaning a reduced number of racing starts per month after an injury (*Figure 3*).



Considering fatigue fractures observed in young STBRs, we observed a low incidence of pelvic and tibia stress fractures rather than sustained in young TBR. Most common trauma are proximal phalangeal fractures in the hindlimbs, apical sesamoid bone fracture of the lateral sesamoid in the hindlimbs and type I fracture of the lateral palmar process of the third phalanx, with a median recovery time of 250, 176 and 148 days, respectively.

Orthopaedics condition in STBRs at the age of yearling are dominated by osteochondrosis of the tarso-crural joints currently managed with arthroscopy, as well osteochondral disease of the stifle al the level of the lateral trochlear ridge of the femur and at the level of the lateral femoral condyle are currently under investigation, to define athletic prognosis in this breed.

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INJURIES AND REHABILITATION IN ENDURANCE HORSES

Annamaria Nagy

Endurance riding has gained significant popularity in the last decade and has been the second most popular Federation Equestre Internationale discipline (after jumping) for a number of years. Despite the increasing number of endurance horses, evidence-based data on orthopaedic injuries in endurance horses is lacking.

Lameness diagnosis in endurance horses can be challenging. On average, approximately 30% of all started horses are eliminated due to gait abnormalities from international endurance rides of 80-160 km distance. The severity of lameness varies greatly and is often not correlated with the severity of injury. Horses showing mild lameness at the vet gate are sometimes not or only minimally lame by the time they arrive in the treatment clinic. In contrast, some mildly lame horses or horses without consistent lameness and successful completion can develop severe, sometimes even non-weight bearing lameness within a few hours. While some horses show clinical signs that suggest the source of lameness, such as a markedly distended and painful fetlock joint or a new and painful swelling in the region of the superficial digital flexor tendon, in other horses even a very thorough and repeated clinical examination does not detect any abnormalities.

Lameness in endurance horses is often transient; it may only become apparent after a long training or race ride and improve with rest. Due to the nature of the discipline, it can be very difficult to mimic the conditions that trigger lameness in a clinic or even in an ambulatory setting. It is therefore paramount that if the lameness is still present when the horse returns home from an endurance ride (or training), it is promptly investigated.

Foot and proximal metacarpal pain are considered the two most common sources of lameness in endurance horses. Complex injuries in the proximal metacarpal region involving the proximal metacarpal bone and the suspensory ligament are more commonly seen in horses training and racing at higher speeds; however, proximal suspensory desmitis and injuries to the proximal palmar metacarpal bone can also be seen in young horses not subjected to high speeds and in older horses racing at low speeds.

Stress fractures similar to those in Thoroughbred racehorses have been described in a population of endurance horses racing at high speeds but stress-related injuries are diagnosed in other countries as well, where endurance horses compete at much lower speeds. There has been a lot of negative publicity on complete and catastrophic fractures but the true incidence of these injuries is unknown. The most common fractures occurring in training and in competition involve the proximal phalanx and the distal metacarpal condyles.

In large endurance stables rehabilitation programmes are often dictated by the racing season and the trainers' preference. The time and length of return to racing can be verified by the horse's competition record but the time to return to training is often unknown. Prognosis for certain lesions (e.g., palmar foot pain) may be better in endurance horses than in horses in other sports disciplines; probably due to the type of the exercise they are exposed to (e.g., not ridden in small circles/tight turns) and due to the stoic nature of many endurance horses. A large study would be desirable to describe injuries in endurance horses and their long-term outcome. This would require close collaboration between trainers, stable veterinarians and referral centres where sophisticated diagnostic imaging and sometimes treatment may take place.

Further reading

Misheff, M., Alexander, G. and Hirst, G. (2010) Management of fractures in endurance horses. Equine Vet. Educ. 22, 623-630.

INJURIES AND REHABILITATION IN WARMBLOOD HORSES

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Prevalence of injuries in warmblood (WB) horses was reviewed in a mixed first opinion and referral population. The presence of multiple lesions, two or more sources of pain and multilimb lameness represented a high proportion of the cases reviewed. Correlation between imaging findings and clinical issues was sometimes challenging, and lack of specificity of nerve and joint blocks[1],[2] was a complication especially when two of more sources of pain were present . Ridden exam was part of the lameness examination when appropriate to do so, and extremely valuable in dressage in order to obtain a complete diagnosis. The treatment and rehabilitation program should contemplate all the lesions present, both active and subclinical in order to reach a satisfactory outcome and to lengthen the sport live of the horse.

Regarding the discipline, in our experience, in dressage the presence of chronic injuries due to repetitive overload and fatigue were more usual, whether in show jumping apart from chronic injuries acute impact and tensional injuries were also present. Diagnosis of osteoarthritis was present in a high proportion of horses. Prevalence of juvenile osteoarthritis (OA) appeared to be increasing. The involvement of subchondral bone pathology was underestimated in radiology. In general, in horses with a primary diagnosis of OA intra-articular therapy was recommended. The use of steroids was only used after a proper diagnosis was reached, as steroid resistance has been recognized in humans and might be one of the reasons of progressive decrease of efficacy with use[3]. If bone edema was suspected or diagnosed in MRI a period of rest was commonly prescribed with the use of bisphosphonates[4] in adult horses.

Soft tissue injuries were generally monitored by ultrasonography and power doppler (PD)[5,6,7] independently of whether regenerative therapy or shockwave therapy was used. For the rehabilitation program reduced loading and gradual exercise was prescribed.

Foot region pain was common and combined with other lesions elsewhere in a high proportion of cases. This fact should be taken into account in order to prescribe orthopaedic shoeing (i.e. deep digital flexor (DDF) tendinitis and suspensory desmitis). During the rehabilitation period work in circles was avoided as most of the lesions found would deteriorate in circle.

Fetlock region lameness was more common than previously reported [8] with a high incidence of medial condyle pathology on the third metacarpal bone. Tenosynovitis of the digital flexor tendon sheath in WB was mostly represented by lateral tears of the DDF tendon as previously reported[9] , manica flexoria partial tears, and superficial flexor (SDF) tendon in fewer cases. Preoperative diagnosis was improved by the use of PD ultrasonography. Surgical treatment was recommended in most of the cases followed by a rehabilitation period either combined with shockwave or intrathecal treatments.

SDF tendinitis in the metacarpal or metatarsal region was less common than expected. This could be a result of a partial referral population as diagnosis is straight forward. The most problematic lesions were subcarpal tears and lateral margin tears with adhesion formation with the accessory ligament of the DDFT. Power doppler monitoring and cross-sectional areas were used in order to adapt the rehabilitation program individually.

High suspensory desmitis was one of the most common injuries especially in dressage. Desmitis in juvenile horses seems to be increasing, probably due to selection of horses with more amplitude of movements and early work. Abnormalities detected in the third metacarpal (MC) were common even in youngsters. Lameness was exacerbated in extended trot and half pass. Most cases were chronic and bilateral and with osseous component. Hindlimb suspensory desmitis was under-represented probably due to the ability of riders to detect bilateral hindlimb issues. Common signs were reduced amplitude of the flying change to the more affected side and lack of impulsion. Subclinical suspensory branch lesions were common in pre-purchase exams. With clinical lesions the prognosis was highly limited by peri-ligamentous fibrosis and bone involvement as previously reported[8].

Correlation between imaging and clinical findings was more challenging in the spine. Cervical facet osteoarthritis was considered of clinical significance if associated with neck movement restriction, unblocked forelimb lameness, contact issues, and neurological problems. Impingement of the dorsal spinous processes was less common than in other breeds (Thoroughbred) and probably combined with further spinal lesions. Lumbo-sacroiliac pain was a common limitation in dressage horses during flying changes and collected exercises, such as piaffe. Rectal ultrasonographic exam is highly recommended as severe findings such as discal hernias and sacralizations with associated pathology in adjacent segments can limit treatment and prognosis, especially in dressage at high levels. The most common causes of retirement were navicular cystic lesions, deep digital flexor tendinitis in jumpers, suspensory branch with osseous involvement, end stage OA, and suspensory origin desmitis with osseous involvement.

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SADDLE FIT FOR WARMBLOODS: KEEP IN MIND THEIR CONSIDERABLE VARIATION IN THORACIC BACK SIZES, ESPECIALLY AT THE WITHERS

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Determing the variations in Warmbloods' thoracic back sizes can significantly aid training stables in selecting a suitable subset of saddles for their, often variable, population. Having suitable saddles to start with, aids the saddle fitter in enhancing safety, performance and welfare in riders and horses.
This pilot study focuses on determining how much Warmbloods' thoracic sizes can differ, where they varry the most and whether sizes differ with age and gender. From all Warmblood back drawings (= templates) made by an expecienced saddle fitter, 54 files were selected. The sample population was balanced for gender (mares and geldings), age (3-25 years) and having ample conformational variation. Multiple back sizes were measured at the withers (gullet), T18 and thoracic spine (back curvature).
Factor analysis revealed maximal variation at the withers (49,7 %), compared to T18 (24,4 %) and the thoracic spine (18,6 %). Mares younger than twelve had wider withers, which varried more. Young horses were asymmetrical by being wider at the left side of the withers. However, at least at some locations, their older counterparts (> 17 years) were significantly wider at the right side. The back curvature angle between seat and cantle region, was rather constant (± 170 °) in 6 to 20 year old horses. Younger and older ones had straighter and more swayed backs, respectively.
In conclusion, Warmbloods can differ significantly in thoracic back sizes. For saddle fitting, the withers are an important region (of variation). Until a certain age, mares may typically need larger gullet sizes than geldings. Also, asymmetry and back curvature seem to differ with age.

CAN THE HOOF BE SHOD WITHOUT LIMITING THE HEEL MOVEMENT? A COMPARATIVE STUDY BETWEEN BAREFOOT, SHOEING WITH CONVENTIONAL SHOES AND A SPLIT-TOE SHOE

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Introduction: As a component of the hoof mechanism, heel movement plays an important role in shock absorption of the equine foot, which is a crucial factor for the orthopedic longevity of equine athletes. Conventional shoeing restricts heel movement.

Materials and methods: In a randomised crossover experimental study in eight horses (16 forelimbs), the mediolateral heel movement was evaluated barefoot, shod with a conventional shoe and with a new type of shoe with a split toe. A displacement sensor was fixed on the heels and measurements were collected at a frequency of 679 Hz during exercise on a high speed treadmill at the walk (1.8 m/s), then at trot (3.5 m/s) and finally at canter (8 m/s). Differences in heel movement during the stance phase in the three studied groups were analysed using a generalised estimating equations approach.

Results: The conventional shoe was associated with significantly reduced heel expansion compared with the split-toe shoe and the barefoot method in all analysed gaits ($P \leq 0.001$). Heel expansion was not significantly different between the split-toe shoe and the barefoot method. Shoeing was associated with a significant reduction in the heel contraction compared with the barefoot method in all gaits ($P \leq 0.038$), except for the heel contraction at the canter using a conventional shoe.

Conclusion: The heel expansion with the split-toe shoe did not differ significantly from the barefoot situation, in contrast with the significant restriction of the heel expansion by 36% when a conventional shoe was used.

HINDLIMB PROXIMAL SUSPENSORY DESMOPATHY AND OTHER SUSPENSORY LIGAMENT INJURIES IN HORSES UP TO FIVE YEARS OF AGE COMPARED WITH OLDER HORSES

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Introduction: Hindlimb proximal suspensory desmopathy (PSD) is a common cause of lameness or poor performance in horses and may occur alone or together with other suspensory ligament (SL) injuries in forelimbs or hindlimbs. Aims: To compare horses with hindlimb PSD ≤ 5 years old (Group 1) and ≥ 6 years old (Group 2).

Methods: Retrospective case-control study from January 2009 to December 2018 (n=923). Concurrent injuries were defined as forelimb PSD or SL branch injuries (≥grade 2 [0-3]) in any limb. Hindlimb PSD was graded mild, moderate or severe based on ultrasonography.

Results: Most horses (92.4%) had bilateral hindlimb lameness ± forelimb lameness. Mean age was 8.7 years (range 2-22); 4.8 years in Group 1, 9.3 years in Group 2. There were 66.8% geldings, 31% mares and 2.2% stallions. Warmblood horses 404/923 (43.8%) predominated. 264/923 (28.6%) horses had concurrent SL lesions: Group 1 43/115 (37.4%), compared with Group 2 221/808 (27.4%). In Group 1, 40.4% of horses had severe PSD, compared with 35.4% of horses in Group 2; severity of ultrasonography grade was not a significant risk factor for concurrent SL injury. In the final multivariable model, age (Odds ratio [OR] 1.76, P=0.009), bodyweight:height ratio (OR 2.27, P=0.001), breed (P=0.008-0.024), symmetry versus asymmetry of ultrasonography grade (OR 1.56, P=0.006) and asymmetry versus symmetry of lameness grade (OR 1.59, P=0.017) were significant risk factors for concurrent SL injury.

Conclusions: There was a higher frequency of occurrence of concurrent SL injuries in young horses compared with older horses. Further investigation is warranted.

TOTAL POWER MEASURED WITH ACCELEROMETRY IN HORSES EXERCISED ON A WATER TREADMILL AT DIFFERENT WATER DEPTHS AND VELOCITIES

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Exercise on a water treadmill is commonly used in horses with locomotor injuries in order to reduce axial load while maintaining muscle activity. Rehabilitation of flexor tendinopathies and experimental osteoarthritis have been made with the water at the level of or over the abdomen/stifle, reducing the depth as the horse improves. Total power TP (i.e. strength by velocity) was studied with an accelerometer fixed in the midline of the sacrum in 6 sound healthy horses exercised for 5 min without water (control), with the water at the level of the fetlock (F), tarsus (T) and stifle (S). Velocities were set at 6 km/h in the control, F and T depths. However, horses were not able to keep this velocity at S, and therefore, it was reduced at 4.8 km/h, which was a comfortable velocity for all the horses. TP presented mean values of 6.661, 7.972, 9.011 and 5.800 W/kg at control, F, T and S depths respectively. It was unknown whether the significant reduction in TP with the water at the S level compared to T was associated with greater buoyancy or reduced velocity or a combination of both factors. In order to elucidate which was the reason for these results, another group of 6 horses were subjected to the same exercise protocol, but with a velocity of 5 km/h. There were not significant differences in TP between T and S depths when the velocity was the same (9.514 vs 9.444 W/kg). In conclusion, TP does not differ between T and S depths.

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PHYSICAL REHABILITATION IN A NON-AMBULATORY TETRAPARETIC DOG WITH STEROID-RESPONSIVE MENINGITIS-ARTERITIS

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Background: Steroid-responsive meningitis-arteritis (SRMA) is an immune-mediated disorder commonly recognised in young dogs. Authors report the rehabilitation approach to a rare SRMA case presentation in a dog with non-ambulatory tetraparesis secondary to intradural haemorrhage.

Case presentation: A 2-year-old male boxer dog, with a MRI and laboratory findings SRMA diagnosis, was referred to Physiotherapy Unit for non-ambulatory tetraparesis due to compressive myelopathy secondary to C6 intradural haemorrhage. At physiatric assessment permanent lateral recumbency, lack of proprioception, bilateral patellar hyperreflexia, forelimb withdrawal areflexia, severe cervical pain and urine retention were observed. The patient was hospitalised and tapering immunosoppressive doses of prednisolone were administered. Physiotherapy started with two daily sessions, that included: massage (10 minutes), PROM exercises (10 reps), flexor reflex stimulation exercises (10 reps), stretching (10 minutes), NMES (15 minutes) and assisted standing position with physioball abdominal support (5 minutes). After 2 weeks absence of pain, ability to maintain the stance and to perform 3-5 steps if supported, and partially spontaneous urination were observed. Consequently, physiotherapy was implemented with assisted underwater treadmill (up to 5 minutes) and standing and/or weight-shifting on a 360-degree balance-board. After 2 months, the patient was able to make longer walks, if supported. Therefore, low cavaletti rails and slalom were introduced. After 3 months, the patient was able to ambulate without support and to urinate spontaneously.

Conclusions: Non-ambulatory tetraparesis secondary to intradural haemorrhage represents the peculiarity of this SRMA case presentation. Glucocorticosteroids and three months of physiotherapy lead to complete recovery of severe tetraparesis and acute cervical pain.

NON-AMBULATORY TETRAPARESIS SECONDARY TO ACUTE POLYRADICULONEUROPATHY IN FIVE DOGS: A PRELIMINARY STUDY ON CORRELATION BETWEEN PHYSIOTHERAPY AND RECOVERY TIME.

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Introduction - Non-ambulatory tetraparesis (NAT) in acute canine polyradiculoneuropathy (ACP) is a commonly recognized peripheral neuropathy in dogs. Aim of this preliminary study was to retrospectively investigate if the number of days elapsed from NAT appearance and 1st day of physiotherapy (PT) (point 1) may affect PT duration (days) (point 2) or number of sessions (point 3) to gain ambulation.

Methods – Clinical records of dogs affected by NAT due to ACP and referred to the clinic for PT were retrospectively analysed. Only dogs with complete clinical records and similar PT approach (massages, PROM, exercises on Physioroll, Cavaletti rails, stairs, TENS and underwater treadmill) were included; the points 1 and 2, and 1 and 3 were statistically correlated using a Spearman test.

Results - Five patients were selected. They were four females and one male, with a mean age of 7.8 ± 1.1 years and a mean body weight of 20.4 ± 6.7 kg. Mean time related to point 1 was 4.2 ± 1.4 days. Mean time for point 2 was of 21.6 ± 5.12 days. Mean number of 38 sessions (median 34) was required. However, a low correlation was observed between points 1 and 2 ($\rho = 0.5643$) and points 1 and 3 ($\rho = -0.1539$).

Conclusions – Results of this preliminary study show that PT can help recovery but with a low correlation between examined parameters. However, a wider number of cases, a control group and comparison with different physiotherapy approaches are necessary to confirm this preliminary results.

ULTRASONOGRAPHIC APPEARANCE AND MANAGEMENT OF PYOGRANULOMATOUS BICIPITAL TENOSYNOVITIS IN A DOG ASSOCIATED TO GRASS AWNS MIGRATIONS

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Introduction: Bicipital tenosynovitis (BT) is a common cause of forelimb lameness in dogs. Pyogranulomatous BT associated to grass awn migration represents a rare condition that can be observed also in athlete dogs.

Description: A 10 year-old female, working dog, German Shepherd presented for a severe left forelimb lameness of 7 days duration. A mild pain was elicited on palpation of the biceps origin and after shoulder flexion with the elbow extended. A mild swelling of the antebrachium was noted. The radiographic study of shoulders and elbows revealed no alteration. The ultrasonographic examination of shoulder revealed no alteration of infraspinatus, teres minor and supraspinatus muscles or tendon neither of the gleno-humeral ligaments or brachial plexus. Joint capsule was hyperechoic, thickened and moderately fluid-filled. Biceps tendon was diffusely inhomogeneous with multifocal core lesions. The bicipital synovial sheath was hyperechoic with poorly defined margins and severely filled by hypoechoic fluid. A fistulous hypoechoic path was identified starting from the distal synovial sheath directing distally. Grass awns were identified medially to biceps brachii muscle belly and in the subcutaneous soft tissue cranially to the radius and removed with ultrasound assistance. Cytological and microbiological exam of the synovial fluid revealed a pyogranulomatous infection (Klebsiella spp.). Dog underwent antibiotic-NSAID therapy and rehabilitation. Dog was clinically and ultrasonographically rechecked 1 month after initial diagnosis and a complete recover was noted.

Conclusions: Ultrasound allowed the accurate characterizations of biceps brachii alterations and was notable in the management of this case. Rehabilitation program contributed to a prompt healing.

CHANGES IN THE KINEMATIC PARAMETERS OF THE STRIDE IN HORSES AFTER TWO SESSIONS OF CAPACITIVE RESISTIVE ELECTRIC TRANSFER APPLIED IN TWO CONSECUTIVE DAYS

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Capacitive resistive electric transfer (CRET) is a radiofrequency at 448 kHz, which has been demonstrated to result in a more efficient running pattern when applied after an exhaustive training session in recreational human runners.

Six sound horses were subjected to two CRET sessions (2 min capacitive; 4 min resistive), applied two consecutive days, in both right and left sides of the neck, shoulder, back and croup. Before (baseline), at 2, 6, 12 h after the first session and at 2, 6 and 12h after the second (i.e. before and at 2, 6, 12, 26, 30 and 36h after the first session), horses were evaluated at walk and at trot in a track, led in hand by the same operator, using a triaxial accelerometer fixed in the sternal region. Velocity (V), stride frequency (SF) and length (SL) were obtained.

At walk, increased median V values were found at 12, 26, 30 and 36h (1.464, 1.452, 1.452 and 1.439m/s) compared to baseline (1.425 m/s). SF decreased at 2 and 6h (0.84 strides/s), at 30h (0.83) and at 36h (0.82) compared to control (0.86). SL increased from 12h (1.75m at 12h, 1.72m at 26h, 1.75m at 30h and 1.75m at 36h) compared to baseline (1.66m). At trot, an increase of V (control: 2.998m/s; 36h:3.456m/s) and SL (control:2.18m; 36h:2.51m) was found.

The application of two consecutive CRET sessions in two days resulted in increased V, and as a consequence, SL increased, and SF was reduced. The elongation of SL might have a positive effect in sport horses.

PROTEIN ALTERATIONS IN RESPONSE TO ENDURANCE RACE, A PROTEOMIC STUDY

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Strenuous exercise induces a variety of physiological adaptations in different body systems. The proteomic analysis enables an identification of different biological pathways interconnected with changes in proteome due to the exercise. The aim of the study was to evaluate changes in protein levels during an endurance race to highlight physiological adaptation to prolonged aerobic exercise.

Thirteen horses, Arabian and Arabian cross, that successfully finished an 80 km endurance race have been enrolled in the study. Blood samples were collected before and 30 minutes after the race. Protein alterations in equine serum samples were analysed using the high-resolution tandem mass tag (TMT)-based quantitative proteomics by employing an UltiMate 3000 RSLCnano system coupled to a Q Exactive Plus mass spectrometer.

Significant quantitative changes in protein concentration after the race were noted in levels of fibronectin, actin, and apolipoprotein. While fibronectin and actin were upregulated, apolipoprotein was downregulated after the race.

Changes in fibronectin levels could be attributed to biomechanical loading during exercise and subsequently induced cartilage extracellular matrix changes. Apolipoprotein is a protein involved in energy supply through lipid metabolism and subsequent hypertriglyceridemia emphasising the importance of fatty acid aerobic metabolism in endurance horses. Changes in actin levels in response to endurance race could be related to muscle remodelling as a process of skeletal muscle adaptation to strenuous exercise.

The preliminary results of the present study indicate that prolonged submaximal aerobic exercise during endurance race affects proteins partaking in metabolic pathways of articular cartilage and lipid utilisation.

EVALUATION OF THE EFFECT OF A SINGLE SESSION OF MANUAL THERAPY ON HORSE LOCOMOTION USING THE LAMENESS LOCATOR® INERTIAL SENSOR SYSTEM

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Introduction: Riders increasingly tend to use manual therapies that are very popular in equestrian circles. However, objective and quantitative validation of the effects of manual therapies are still very rare in veterinary medicine.

Aim : To assess the impact of a single session of osteopathy on horse locomotion by means of the Lameness Locator® inertial sensor system.

Horses : 19 sports horses of various age, breed and activity.

Materials and Method: First, all the horses formed the control group over a month's period, following exactly the same evaluation protocol as during treatment period, in order to evaluate the natural variability of the parameters. Then, at least three months later, all the horses formed the treated group after receiving a single osteopathic treatment. They were again followed up during 1 month, and assessed at D0 before treatment, D2, D7 and D30 by means of a complete orthopaedic examination (orthopedic lameness score), and the Lameness Locator® system (LL lameness score, head and pelvis maximum and minimum heights) **Results** : A high variability was observed in the both groups. Nevertheless, the percentage of sound horses or with improved lameness as observed during the orthopaedic exam was noticeably higher in the treated group : 29% improved vs 18% in the control group on D2, 50% improved vs 39% of controls on D7 and 53% versus 47% of controls on G30. . Lameness scores were significantly decreased in the treated group on D7 for the LL lameness score (1.1±0.9 in treated horses vs 1.9±1.6 in control horses, p=0.012) and on D30 for the orthopaedic lameness score (1.2±1.3 in treated horses vs 2.1±1.6 in control horses, p=0.001).

Conclusion : Further investigations with a more homogenous population and more targeted pathology are necessary to deepen and validate statistically our results.

SURFACE ELECTROMYOGRAPHY AND KINEMATIC STUDY IN DOGS TRAINING ON AN IMOOVE-VET™ MOTORIZED PLATEFORM

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Introduction: The Imoove-vet® (*) is a motorized rotating platform for proprioceptive and postural rehabilitation recently adapted for dogs. In order to implement reasoned rehabilitation exercises with this device, it is important to understand how muscles and different joints act with this kind of movement, which is different from the natural locomotion (lack of swing phase).

Materials and Method: The activity of 6 muscles of the limbs and trunk was recorded by means of surface electromyography, and a bidimensionnal kinematics analysis was realized in two young adult sound dogs exercicing on a Imoove-vet®, at variable tray inclination and speed.

Results: Ranges of motions (ROM) are only influenced by tray inclination and are of small amplitude, well below ROM in the walking and trotting dog. The only ROM noticeables variations were observed for the hips and shoulders and for the maximal slopes. Cyclical muscles activities (alternating active and rest phases) were observed with low tray speeds. Increasing the tray speed induces sustained contractions lasting over several tray cycles. They are of isometric type for small tray inclinations, or an alternating of concentric and eccentric contractions for higher tray inclinations. At the stifle, a sustained co-contraction of the antagonists is observed.

Discussion: The limbs tend to accompany the tray movement to maintain contact with the plateau without seeking to oppose it, and muscles activities tend to limit the range of motion and stabilize joints

Conclusion: This study allowed us to make some recommendations regarding the use of this device for rehabilitation and for athletic dog training.

(Allcare Innovations, 26500 Bourg-lès-Valence, France)*

EFFECT OF EXERCISE ON THE DIAMETER OF THE BICEPS TENDON IN SPORTING BORDER COLLIES

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Introduction/purpose: A prospective study was performed to determine if rest and exercise could have an effect on the diameter of the biceps tendon in sporting Border Collies (BC).

Matherial and methods: Eighteen BC, agility dogs, 9m, 2mc and 7fs, mean age 6,1 years, were selected. The inclusion criteria were: 1) an orthopedic examination 2) acute or chronic shoulder lameness with one healthy shoulder 3) enrolment in a rehabilitative program 4) normal biceps tendon and ultrasound measurement at time 0, after 2, 4 and 6 months. The measure was obtained just distal to the bicipital groove, in a longitudinal scan plane. Initially the activity of the patients was severely restricted. From two to four months, the patients were allowed to swim and to increase the duration and the speed of the walk. From four to six months the patients were allowed to increase significantly the exercise and to return gradually to a full activity.

Results: 66% of patient, with a chronic history of lameness, had a reduced biceps tendon diameter in the healthy shoulder at the first examination compared to the last examination by 3% ($p<0,05$). In six patients presented with an acute history of lameness, there were no significant differences in the diameter of the biceps tendon at the presentation and six months later.

Discussion: This study suggests that strong exercise could increase and prolonged rest could decrease the diameter of the biceps tendon. This parameter can be used to check the effect of the rehabilitation program in sportive patients.

THE ACUTE EFFECT OF PARACHUTE-RESISTED RUNNING ON HEART RATE IN DOGS

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Introduction: Parachute-resisted running is a training method in human athletes to improve muscular power and acceleration. There is a lack of research on the effects of resisted running to improve canine physical fitness.

Objective: The aim of this study was to compare the acute effects of parachute-resisted and unresisted running on heart rate (HR) in dogs.

Methods: Two single-case experimental (N-of-1) studies with alternating interventions were implemented. The dogs were 20-40 kg and weather conditions were controlled. Heart rate was measured by recording of inter-beat intervals with Polar V800 heart rate monitor and H7 sensor during five phases; Baseline, Unresisted running, Baseline, Parachute-resisted running, Baseline. Baseline phases were recorded at rest when HR was steady for three subsequent minutes. Unresisted and parachute-resisted phases were randomised and recorded during 200 meter runs on an outdoor course. The results were visually displayed in graphs and changes within and across phases were non-statistically analysed.

Results: Rapid changes were present in both intervention phases compared to baselines, confirming acute effects on HR. Parachute-resisted running resulted in decreased mean HR by 9% and 18%, lower shift in level and increased running times by 36% and 59% compared to unresisted running, indicating lower cardiorespiratory workload during parachute-resistance. However, during resistance the reduction in mean HR was small relative to increased running times and trendlines showed increasing HR within the parachute-resisted phase, implying increasing cardiorespiratory workload compared to unresisted running.

Conclusion: Parachutes can be used in dogs to produce resistance, hence increased cardiorespiratory workload at lower velocity. The additional knowledge from these randomised and controlled trials is useful in the creation of canine rehabilitation and exercise protocols.

PHYSIOLOGIC RESPONSES IN WORKING DOGS BEFORE AND AFTER THREE DIFFERENT FIELD TRIALS

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Introduction - Over the last years, competition dedicated to working dogs have greatly expanded in order to select the best canine individuals for Search-and-Rescue (SAR) activity. Aim of the this study was to investigate the effects of exercise on the respiratory rate (RR), heart rate (HR) and rectal temperature (RT) in a group of SAR dogs involved in three different field trials.
Methods - Nine healthy working dogs of different breed and age (mean 3.3 years) were included in this study. All animals underwent three working sessions (rubble, search on field, obedience) in three different spring days. RR, HR and RT were monitored for each dog at rest, immediately before and immediately after the working session. Environmental temperature and humidity were also recorded. Data were analyzed by ANOVA Post Hoc Bonferroni test ($P<0.05$).
Results – RR values increased significantly after the competition, while they remained on similar values to those at rest in the pre-competition phase. Only in the obedience trial an increased RR was observed before the working session, probably because the dogs were panting due to hot climate (22°C). HR values increased significantly in all the phases, both reflecting an anticipatory response given to the excitement to competition and exercise intensity. RT was significantly increased only after search on rubbles and obedience.
Conclusions – HR was only the parameter significantly increased in search pre-competition phases, probably due to the adrenaline secretion, that anticipates intensive physical activity. Conversely, RR and RT apparently were more influenced by environmental parameters and physical exertion.

FELINE REHABILITATION: TESTING TENS CURRENTS IN THE TREATMENT OF FIVE CATS WITH DEGENERATIVE JOINT DISEASE ASSOCIATED WITH CHRONIC PAIN.

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Introduction: Degenerative joint disease (DJD) has a high prevalence in domestic cats and can be associated with pain. The more severe lesions appear to be in the lumbar or lumbosacral area. Low frequency impulse alternating currents (TENS) are used for pain relief and the mode of action is based on the theory of gate control.

Materials and methods: Five cats with DJD confirmed radiologically and associated with chronic pain were included in this retrospective study. Pain on palpation of the spine was valued using a visual analogue scale VAS and Feline musculoskeletal pain index (FMPI) was filed by the owners. The 5 cats were treated with transcutaneous electrical nerve stimulation (TENS) applied every day during a month, the patients were kept in domestic conditions, and the owners were instructed to apply it. After a month the process of pain evaluation was repeated to determine the effects of the treatment.

Results and discussion: Five cats were treated with TENS currents applied every day, after a month, all of them show significant pain reduction during the palpation of the spine and improve the FMPI. In feline rehabilitation is important to use a hands off approach whenever possible, keeping our patients in domestic conditions, it may be a significant cause of the success in the treatment.

In conclusion, physical therapy and rehabilitation are potentially beneficial for cats. Animal studies are in their infancy but this paper is a good evidence of the effectiveness of TENS currents on chronic pain reduction in cats with DJD.

"THE SESSIONS WERE ALL BASED ON MY DOG'S ABILITY" – A QUALITATIVE STUDY OF OWNERS' EXPERIENCES OF UNDERWATER TREADMILL EXERCISE IN THEIR DOGS

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Background Underwater treadmill (UWTM) exercise is commonly used in canine rehabilitation to provide therapeutic exercise during locomotion. The UWTM enables adjustments of movements in walk and at trot depending on the individual needs. So far, quantitative research has studied the effects of UWTM exercise. However, there is no qualitative research concerning how UWTM exercise affects dogs during the rehabilitation session. The aim of this study was to investigate the owners' experience of UWTM exercise in their dogs.

Methods A qualitative content analysis with inductive approach was used in this study. Individual semi-structured interviews were conducted with five purposely sampled owners with dogs that had performed UWTM exercise for at least two sessions the last six months.

Results Three themes embracing ten categories were identified from the data. The themes are termed 1) Experienced attitudes in dogs performing UWTM exercise, with the categories covert behaviors, overt behaviors, motivation during the sessions, learning; 2) Interplay between dog-owner-physiotherapist, with the categories individualized exercise, interaction between dog and physiotherapist, interaction between dog and owner; 3) The relationship between dog training and UWTM exercise, with the categories UWTM as prophylaxis, effect of mental training on UWTM exercise, no association.

Conclusion Owners perceived that their dogs had both positive and negative attitudes towards UWTM exercise. The dogs' attitudes were affected by the interaction between dog-owner-physiotherapist and the dogs' everyday training. This study may lead to further development of individualized rehabilitation protocols.

OSTIUM PRIMUM ATRIAL SEPTAL DEFECT IN A THOROUGHBRED GELDING DOCUMENTED USING REAL-TIME THREE DIMENSIONAL (4D) ECHOCARDIOGRAPHY AS AN UNUSUAL CAUSE OF POOR EXERCISE TOLERANCE

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Poor exercise tolerance is a common and complex clinical syndrome in the horse. Congenital cardiac diseases are uncommon, Atrial septal defects (ASD) are rare and usually an incidental finding. This report describes a large ASD in a horse associated with poor performance that was characterised with 4D echocardiography

An 11-year-old Thoroughbred gelding with a history of persistent poor exercise tolerance underwent abdominal and thoracic imaging to evaluate unrelated weight loss. No cardiac murmurs or rhythm disturbances were present. A large ASD was identified with incomplete formation of the septum primum and septum secundum. The defect was located in the ventral atrial septum, below the fossa ovalis, and its left sided opening was in close proximity to the mitral valve. It measured between 2.7-3.5cm in length and varied in diameter from 1.2-2.1cm in width on the left atrial side to 2cm in width on the right atrial side. There was mild pulmonary artery enlargement and subjectively enlarged right atria and ventricle. 4D-echocardiography confirmed the location and shape of the ASD and confirmed the apparent widening of the ASD as it passed through the septum.

ASDs are not associated with cardiac murmurs and represent a previously undocumented cardiac cause of poor performance in this horse. Given the lack of cardiac murmur related to low pressure differences between atria, the prevalence of atrial septal defects has previously not been evaluated. This case suggests that echocardiography may have value in horses with no auscultatable cardiac abnormalities after exhaustive testing of other body systems.

IMPACT OF A TRAINING PROGRAM WITH THE MOTORIZED PLATFORM IMOOVE-VET® IN AGILITY DOGS

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Introduction: In addition to speed, power and flexibility, agility requires significant athletic skills in coordination and balance. Motorized rotating platforms for proprioceptive and postural rehabilitation and athlete preparation have been developed for more than 10 years in humans. This innovative technique has been recently adapted to the dog with the Imoove-Vet®(*).

Aim: To evaluate the effects of a progressive training program with the Imoove-Vet® on the physical capacities and performance in agility dogs.

Dogs – Materials and Method: The study was carried out in nineteen agility dogs, eight as a control group, and eleven following a two session per week training program with the Imoove-Vet® device over six weeks. Limbs circumferences measurements (spring tape measure), temporo-spatial gait analysis (Gaiterite® walkway system), and qualitative and quantitative video analysis of dogs performing on a standardized agility course were performed at day 0 and week 6. The owners opinion was also requested (questionnaire).

Results: The most significant objective results are increased limbs circumferences, reduced number of faults in the contact zones, and decreased weave poles crossing time in the trained group. Correction of spatio-temporal parameters in almost all the trained dogs with initial gait asymmetries, and a better distribution of the maximal pressure between the thoracic and pelvic limbs (ratio) were also observed.

Conclusion: This study is the first to show a positive impact of a training protocol with a motorized rotating platform on the physical capacities and performance in agility dogs. These encouraging observations provide opportunities for further investigations.

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EVALUATION OF NEUROMUSCULAR ELECTROSTIMULATION (NMES) IN THE EQUINE BACK

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Introduction: Back pain is concern for riders and veterinarians, and can be associated with back amyotrophy. NMES is often used in horse rehabilitation for such conditions. However studies validating this method are rare in horses.

Aim: To evaluate the impact of a NMES protocol for the horse back; to validate a parameter for assessing muscle strength.

Horses : Six normal and not ridden horses from the authors' Institution educational herd.

Materials and Method : Three horses received a bilateral NMES of the thoraco-lombar spine at a rate of 3 sessions per week with a progressive protocol lasting 6 weeks. Three horses were the control group (no treatment). Ultrasound morphometric measurements (m. Erector spinae thickness and m. multifidus area), and pressure algometry (Mechanical Nociceptive Threshold, MNT) were performed before treatment, then at 3 weeks and 6 weeks. Muscular Threshold Response to Electrostimulation (MTES) and Maximal Comfortable Intensity (MCI) were determined at each NMES session in the treated horses.

Results: The treated horses showed a significant rise of MNT (6,1$\pm$1,4 Kg/cm² at D0; 7,0$\pm$1,4 Kg/cm² at S3, 8 $\pm$ 1,4 Kg/cm² at S6; p = 0,003; no significant change for the control group), a linear and significant increase of MCI (24$\pm$4,8 mA at D1, 75,8$\pm$7,9 mA at S6) and of the ratio MCI/MTES (2$\pm$0,4 at D1; 6,1$\pm$1 at S6). The average thickness of m. Erector Spinae was also slightly increased (+ 9,7%).

Discussion: An increase in MCI would indicate the ability to a greater spatial recruitment of motor units, and the likely ability to develop a greater muscle strength.

Conclusion: A longer period (8 weeks) of NMES is, a priori, needed to better objectify an increase in muscle mass. MCI and MCI/MTES ratio appear to be valid quantitative parameters for assessing muscle strength.

CLINICAL SIGNS ASSOCIATED WITH ACUTE DESMITIS OF THE SUPRASPINOUS LIGAMENT IN HORSES.

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Introduction: The purpose of this case series is to describe the clinical signs associated with acute desmitis of the supraspinous ligament.

Material and Method: Retrospective case series. Five horses were included, 4 Swedish Warmblood used for riding and one Swedish Standardbred Trotter used for racing. Age were between 4-12 years and gender distribution were 4 mares and one gelding, all with sudden onset of back symptoms and a complete diagnostic work up including: Lameness examination with flexion tests, palpation and lounging, positive analgesia of the back (riding horses only), radiographs and ultrasound of the back.

Results: Confirmative ultrasound findings of the supraspinous ligament were hypoechogenic areas, disruption of longitudinal fiber patten, and irregular bony surface of the attachment. Suggestive radiological findings were densification of the ligament. Lesions were located between Th12-L1 and from 1-3 affected ligaments in consecutive order. All horses were in training prior to developing symptoms and one horse had a history of trauma. All horses had a sudden onset of back pain. Clinical signs were rearing and bucking when ridden n=4 (all riding horses), discomfort when saddled/tacked n=5, signs of discomfort when palpated directly above the spinous processes where the lesion was located n=5.

Discussion/conclusion: All cases have a history of sudden onset of violent rejection to being ridden and show significant signs of discomfort on palpation of the spinous processes above the lesions. Acute ligamentum supraspinatus desmopaties should be a differential diagnosis when horses are presented with this combination of symptoms.

MARKERS OF OXIDATIVE STRESS IN SEARCH AND RESCUE DOGS DURING FIELDWORK

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Exercise can result in oxidative stress characterised by an imbalance between reactive oxygen species (ROS) and antioxidants what can have a negative influence on homeostasis. The aim of the study was to evaluate oxidative stress in Croatian Mountain Rescue Service dogs after a simulated field search exercise.

Eighteen healthy dogs of different breeds, mean age 3.05 (±1.85) years were included in this study. Two blood samples were taken from the dogs, early morning before and immediately after the 6 hours fieldwork. The analysis consisted of determination of two serum indicators of oxidative stress - reactive oxygen metabolites (d-ROMs) and biological antioxidant potential (BAP) - and two erythrocytes antioxidant enzymes- glutathione peroxidase (GPx) and superoxide dismutase (SOD).

Significant decreases ($p<0.05$) in serum level of d-ROMs and erythrocyte activity of SOD were recorded after the fieldwork. A decreasing trend in BAP level and GPx activity was also observed post activity, but not statistically significant.

Increases in SOD and GPx enzyme activity in erythrocytes corresponds with enhanced resistance to oxidative stress. Our study demonstrated decreases in SOD activity, which could indicate the reduction in enzymatic antioxidant activity. BAP represents total antioxidant potential, while d-ROMS measure pro-oxidant status, and can give an estimate on potential ROS production. In trained individuals, due to repetitive endurance training, oxidative stress markers remain unaltered.

The conclusion of our study is that a proper moderate intensity, long duration exercise in search and rescue dogs could lead to conditioning and improvement on the canine organism to respond to oxidative stress.

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