significantly less synovial hyperaemia and wear lines were present in the IVP group. Additionally, a significantly higher area percentage of cartilage oligomeric matrix protein, collagen type II and glycosaminoglycans was seen in the articular cartilage of the IVP group.

Main limitations: This study assessed the short-term effect of the IVP on a limited number of horses, using an osteoarthritis model.

Conclusions: Equine allogeneic chondrogenic induced mesenchymal stem cells combined with equine allogeneic plasma seems a promising treatment for osteoarthritis in horses.

Ethical animal research: The study protocol was approved by the local ethics committee of Global Stem cell technology (approval number EC_2015_002; Permit Number: LA1700607).

Sources of funding: Flemish Agency for Innovation and Entrepreneurship (Vlaio, grant number 130543) and Global Stem cell Technology NV.

Competing interests: J.H. Spaas is shareholder in Global Stem cell Technology (GST) NV owners of Arti-Cell® Forte. S.Y. Broeckx, J.H. Spaas and L. Van Brantegem are all employed by GST. S.Y. Broeckx and J.H. Spaas are inventors of several pending patents owned by GST (BE2012/0656; WO2014053418A9; WO2014053420A1; PCT/EP2013/075782). The other authors declare no conflicts of interests.

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THE INFLUENCE OF RIDER WEIGHT ON EXERCISE-INDUCED CHANGES IN THORACOLUMBAR DIMENSIONS AND EPAXIAL MUSCLE TENSION AND PAIN

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Background: There is increasing debate concerning the appropriate rider bodyweight for horses. Studies have investigated the effect of saddle-fit and rider position on force distribution under a saddle; however, none have assessed the effect of rider weight on the horse.

Objectives: To investigate the effect of rider:horse bodyweight ratio on thoracolumbar dimensions and epaxial muscle tension and pain.

Study design: Prospective, randomised, cross-over pilot.

Methods: Six horses in regular work were ridden by four riders of comparable ability, but differing rider:horse bodyweight ratios (>10 ≤ 12% [L = Light], >12 ≤ 15% [M = Moderate], >15<18% [H = Heavy] and >20% [VH = Very Heavy]). A 30 min exercise test, predominantly in trot and canter, was performed. Test abandonment criteria relating to lameness or behaviour were predetermined. Horse thoracolumbar width at predetermined sites and epaxial muscle tension and pain were assessed before and after ridden exercise. Saddle-fit for horse and rider was assessed.

Results: All tests for riders H and VH were abandoned (after mean = 16.6 and 8.3 min, respectively). The mean change in thoracolumbar width after exercise was significantly different between rider L and riders H and VH ($P = 0.02$). Mean thoracolumbar width increased with riders L and M (3.9% and 1.9%, respectively) and decreased with riders H and VH (−3.4% and −2.8%, respectively). There was no significant increase in tension or pain scores for rider L; tension scores increased significantly for riders M and H ($P<0.05$) and there was a trend for increased pain score for rider VH ($P = 0.08$).

Main limitations: The saddles were too small for riders H and VH; saddle-fit was not ideal for each horse. Although potential confounders, this represents a 'real life' scenario, such as that at a riding school.

Conclusions: High rider:horse bodyweight ratios negatively influenced thoracolumbar width changes with exercise and positively influenced development of tension and pain. Excessive rider weight may accentuate the negative effects of an ill-fitting saddle.

Ethical animal research: The study was approved by the Animal Health Trust Clinical Ethical Review Committee (AHT 28-2016). Owners gave consent for their animals' inclusion in the study. **Sources of funding:** World Horse Welfare, the Saddle Research Trust, Frank Dyson, British Equestrian Federation, British Horse Society, Pony Club, UK Polocrosse Association, The Showing Council, The Showing Register, The Society of Master Saddlers, Riding for the Disabled, British Eventing, British Dressage, the British Horse Foundation, the Worshipful Company of Saddlers and Endurance GB. **Competing interests:** None.

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THE INFLUENCE OF RIDER BODYWEIGHT ON SALIVARY CORTISOL CONCENTRATIONS AND SPONTANEOUS BLINK RATE FOR HORSES PERFORMING A STANDARDISED EXERCISE TEST

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Background: Judgements concerning optimal rider weight for horse size are rarely informed by objective science, despite the potential welfare ramifications of a heavy rider on a mismatched horse.

Objectives: To measure the equine stress response to riders of differing weight.

Study design: Prospective, cross-over, randomised trial.

Methods: Six horses in regular work, 500–600 kg bodyweight, were ridden by four riders (rider bodyweight: horse body weight ratio 10–12% [L = Light], >12 ≤ 15% [M = Moderate], >15<18% [H = Heavy] and >20% [VH = Very Heavy]), in a standardised dressage test lasting 30 min. The test was abandoned for ≥grade 3 lameness or demonstration of ≥10 behavioural markers [1]. Salivary cortisol analyses (Salimetrics™ ELISA kits) were performed on mouth swabs collected at 06.00 h, directly before exercise and 30 min after exercise. Spontaneous Blink Rate (SBR), an indicator of the stress neurotransmitter dopamine, was recorded immediately before and after exercise, for 15 min.

Results: All 13 H and VH rider tests were abandoned (lameness, n = 12; behaviour, n = 1), as was one of 12 M rider tests (lameness). Post-exercise SBR was elevated compared with pre-exercise values for rider H ($P<0.05$, Wilcoxon's matched pairs test). There were no differences in cortisol concentrations.

Main limitations: The short duration of the abandoned tests may have influenced the results for riders H and VH (mean 8.3 and 16.6 min respectively).

Conclusions: Increased SBR for the H rider and the high termination rate for H and VH tests are both possible indicators of a stress response to heavier riders. Further work is required to establish the welfare implications of these initial findings.

Ethical animal research: The study was approved by the Clinical Ethical Review Committee of the Animal Health Trust, 28-2016. There was informed owner consent. **Sources of funding:** The study was generously supported by World Horse Welfare, the Saddle Research Trust, Frank Dyson, British Equestrian Federation, British Horse Society,

Pony Club, UK Polocrosse Association, The Showing Council, The Showing Register, The Society of Master Saddlers, Riding for the Disabled, British Eventing, British Dressage, the British Horse Foundation, the Worshipful Company of Saddlers and Endurance GB. **Competing interests:** None declared.

Reference: [1] Dyson, S., Berger, J., Ellis, A. and Mullard, J. (2017) Development of an ethogram for a pain scoring system in ridden horses and its application to determine the presence of musculoskeletal pain. *J. Vet. Behav.: Clin. Appl. Res.* https://doi.org/10.1016/j.jveb.2017.10.008

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THE EFFECT OF AQUATRAINING AND DRY TREADMILL TRAINING ON MUSCLE MORPHOMETRIC AND MUSCLE METABOLOMICS IN HORSES

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Background: Little is known about the effect of training on muscular metabolism and morphometry because of a lack of standardised equine studies.

Objectives: (1) comparing muscle morphometric changes induced by dry treadmill training (DT) vs. aquatraining (AT), (2) comparing metabolic profiles of the pectoralis profundus (PP) muscle and vastus lateralis of the quadriceps femoris (QF) in dry treadmill trained Friesians (DTafter), untrained Friesians (DTbefore) and untrained Warmblood horses.

Study design: Prospective clinical study.

Methods: Twelve untrained Friesians were subjected to two different training programmes: seven horses completed 8 weeks of AT, five horses a DT training programme. Morphometric assessment of 15 muscles was performed at start, after 4 weeks and at finish using ultrasound. Muscle biopsies were harvested from the DTbefore and DTafter group at start and finish from the PP and the QF. Metabolomic profiling was performed by (RP)/UPLC-MS/MS and HILIC/UPLC-MS/MS.

Results: (1) AT increased muscle diameter of the cervical and thoracic part of the trapezius muscle, brachiocephalicus, QF, semitendinosus, semimembranosus and the thoracic part of the erector spinae (2) DT significantly increased long chain and decreased medium chain acylcarnitines in PP and QF. Early and late stage glycolytic intermediates and pentose-phosphate pathway intermediates were significantly increased in the QF. A significant increase in oxidised glutathione and intermediates of the glutamine/glutamate metabolism and decrease in glycine and acetyl-glycine was found in the PP ($P<0.05$).

Main limitations: The effect of AT on muscle metabolomics was not studied.

Conclusions: AT causes hypertrophy of muscles in the forelimb, back, and hindlimb, particularly muscles involved in forelimb elevation and forward movement, flexion of the hindlimb and muscles used for spine extension. Following 8 weeks of DT, an upregulation of fat oxidation and glycolysis in QF muscle was shown, while the muscle PP showed an upregulation of fat oxidation and amino acid metabolism.

Ethical animal research: Ethical approval AVD262002015144. **Sources of funding:** No funding was provided. **Competing interests:** None declared.

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THE EFFECT OF SOLE PADDING AND PACKING MATERIALS ON IMPACT VIBRATION IN A GROUP OF MILITARY HORSES

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Background: Sole-packing and padding materials may affect foot-surface impact vibration. They warrant further investigation due to the diversity of products and their potential to affect horse soundness and performance.

Objectives: To determine the effect of three experimental shoeing conditions on impact vibrations.

Study design: Experimental, quantitative analysis of impact vibration.

Methods: Seventeen military horses were allocated to one of three experimental shoeing groups: 'firm' sole-packer, 'soft' sole-packer and 'leather pad'. Horses were equipped with a single forelimb, high-range accelerometer (1000× gravity, 5000 samples/s) and trotted in-hand under a 'steel shoe' baseline condition followed by the experimental shoeing condition of their group. Foot-surface impacts were extracted from the accelerometer output and a Fast Fourier Transform applied from impact for 30 ms. Impact vibrations were characterised in terms of total (TOTAL) and maximum signal power (MAX). Frequency at MAX (fqMAX) was expressed as low (centre frequency ≤313 Hz), low-middle (314–625 Hz), middle-high (626–938 Hz) and high (≥939 Hz). A linear mixed effect model (TOTAL, MAX) and a generalised linear model (fqMAX) tested for differences between shoeing conditions.

Results: In the 'firm' group ($n = 6$), proximodistal TOTAL and MAX were significantly greater under the experimental condition compared with the baseline (both $P<0.0001$). The proportion of foot-surface impacts in the 'middle-high' and 'high' fqMAX categories increased significantly between baseline and 'firm' shoeing conditions ($P<0.001$). No significant differences between the baseline condition and the other two experimental shoeing conditions were detected.

Main limitations: To reduce hoof damage it was only possible to assess one experimental shoe condition per horse, which always followed the assessment of the baseline condition.

Conclusions: In this study a firm sole-packer increased impact vibration power and fqMAX. This differs from previous work. Horse type and surface properties may influence the effect of sole-packers on impact vibration. Further work is needed to fully understand the shoe-surface interaction.

Ethical animal research: Informed owner consent was obtained and the study was approved by the Royal Veterinary College's Ethics and Welfare Committee. A representative of the Household Cavalry Mounted Regiment gave informed consent for the horses' inclusion in this study. **Sources of funding:** Royal Veterinary College Mellon Trust and Horserace Betting Levy Board (HBLB). **Competing interests:** None declared.