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Editorial

Horses, saddles and riders: Applying the science

An enthusiastic crowd of 400 people gathered at Anglia Ruskin University in Cambridge, UK on 29 November 2014 for the second International Saddle Research Trust Conference on the theme of *Horses, Saddles and Riders: Applying the Science*. The conference was organised under the auspices of the Saddle Research Trust (SRT) which is a charitable organisation based in the UK established with the intention of stimulating and supporting research into the influence of saddles on the welfare, performance and safety of horses and riders using objective scientific methods. The SRT aims to provide a coordinated, focused approach to research in these areas, to facilitate publication of the findings in scientific journals and dissemination of the results to the equestrian world. This approach allows the SRT to act as a link between research, education and the industry. The trust supports research into all aspects of the interaction between the horse, saddle and rider. Areas of specific recent interest include studying welfare, performance and safety issues related to the use of a saddle, the role of the saddle in equine and human back problems, characterising behavioural issues of horses associated with saddle-related discomfort, assessing the effects of saddle design on rider performance and health and designing saddles for disabled riders. Further information about the SRT is available on the website www.saddleresearchtrust.com. Sponsors of the conference were World Horse Welfare, a practical and forward-thinking charity that believes in using scientific evidence to help guide its work, Amerigo saddlers, a company that advocates research as a basis for improving product design, the British Equestrian Federation (BEF) and Horse and Hound.

The morning programme, chaired by Dr Charlotte Nevison, Director of Research Students, Faculty of Science and Technology, Anglia Ruskin University, explored the relationship between horse, saddle and rider with particular emphasis on research that has been reported since the first SRT conference 2 years earlier.

The conference began with a lecture from Anne Bondi, founder and director of the SRT, that focused on the complexity of the horse, saddle and rider interaction and discussed how welfare, performance and safety issues can arise when the 3 elements do not interact optimally. She talked about the issues faced by competitors who participate in seated sports including cyclists, rowers and riders, focusing on their interface with the saddle or seat. She showed some graphic photos of injuries sustained during these sports to emphasise the necessity of ensuring that the saddle fits the rider to facilitate an effective and pain-free performance. She reported on a study carried out with her co-authors at the University of Sunderland that measured asymmetry in the rider, using hip rotation as the marker (Gandy *et al.* 2014). This revealed that 83% of the participants showed up to 30° more rotation in the right hip compared with the left, which could contribute to rider injury (**Fig 1**).

The next speaker was Dr Sue Dyson, Head of Clinical Orthopaedics at the Centre for Equine Studies at the Animal Health Trust (AHT) who described a series of studies performed with doctoral student Line Greve. The first topic built on some preliminary data presented at the first SRT Workshop that addresses why the entire saddle slips to one side. Asymmetries of the horse, the rider or the saddle can contribute to the problem and 2 studies were performed in an effort to learn more about the aetiology of saddle slip. In the first study, 128 lame and sound horses were assessed, all ridden by at least 2 riders (Greve and Dyson 2013). Seventy-one horses had hindlimb lameness, 54% of which had saddle slip when ridden by at least 2 riders (**Fig 2**). In 97% of horses saddle slip was abolished when lameness was eliminated by diagnostic analgesia, verifying a causal relationship. In 2 horses the saddle continued to slip after resolution of lameness. Both horses had asymmetrically flocked saddles and when ridden with correctly fitting saddles, no saddle slip was apparent. Neither the severity of lameness nor the source of pain within the limb affected the presence or absence of saddle slip. When associated with lameness, the amount of slippage was greater with a lightweight rider than with a heavier rider. However, the reverse was true when slippage was a consequence of the saddle being constructed asymmetrically.

In the second study, the authors examined 506 horses from 80 yards (Greve and Dyson 2014a). Saddle slip was identified in 62 horses and was most often associated with the presence of hindlimb lameness, with or without concurrent forelimb lameness, or gait abnormalities although most of the riders were not aware that their horse was lame. Horses with hindlimb lameness were 52 times more likely to have saddle slip than nonlame horses. In the majority (60%) of cases, the saddle slipped toward the side corresponding with the lame or more lame limb and was greater on circles than straight lines.

The horse's back shape and symmetry were also contributing factors. A saddle that fits well, has even contact with the horse's back and is flocked uniformly is actually more likely to slip than a poorly-fitting saddle (Greve and Dyson 2014a). It is thought that the less well fitted areas offer resistance to slipping and help to hold the saddle in place. On the other hand, when the saddle is perfectly fitted, there are no obstructions to prevent it from sliding over the horse's back. A more convex (rounded) back shape, especially in the region under the caudal aspect of the saddle, also contributed to slippage. Crookedness of the rider was more likely to be an effect, rather than a cause, of saddle slip; when the saddle has shifted to one side, it is almost impossible for the rider to sit vertically in the middle of the horse's back. Veterinarians and trainers should be diligent in observing the rider and saddle from the front and rear to check whether they are centred and symmetrical (**Fig 3**). If the saddle persistently slips to one side, it may help to have a rider who is known

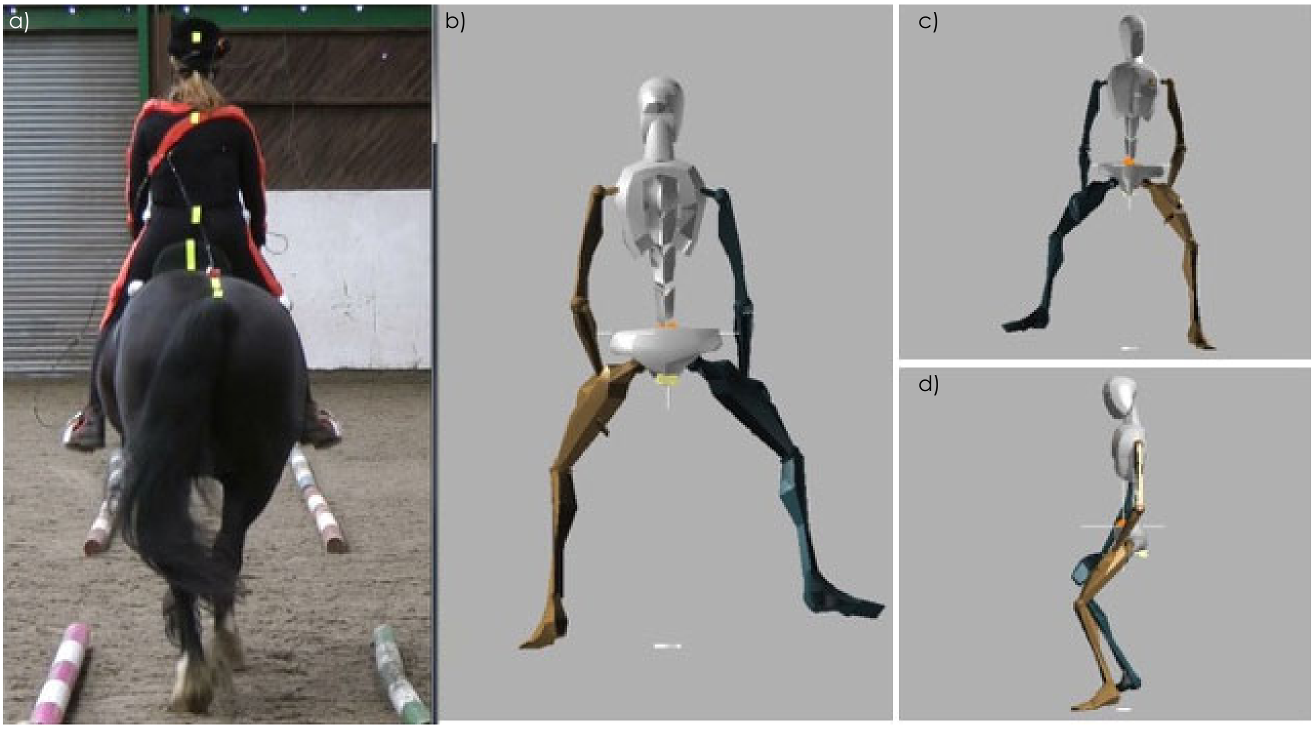

***Fig 1:** a) Caudal view of a rider wearing the Exsens body suit. Note the outward rotation of the right foot reflecting outward rotation of the rider's right leg from the coxofemoral joint distally. The right heel is higher than the left. b) Caudal modelled view of the rider; the black right leg is rotated out more than the brown left leg. c) Cranial modelled view of the rider; the black right leg is rotated out more than the brown left leg. d) Modelled image from the side showing the asymmetric leg positions.*

***Fig 2:** Saddle slip caused by hindlimb lameness. a) The dressage saddle is slipping to the left. b) The western saddle is slipping to the right. In both horses abolition of hindlimb lameness by diagnostic analgesia resolved the saddle slip.*

to be symmetrical ride the horse and, if the saddle still slips to the same side, then a lameness evaluation should be considered.

A longitudinal study of changes in back dimensions over a period of one year was performed in 104 horses with measurements being made every second month. Shape changes were positively influenced by improved saddle fit, increased work level, season (summer vs. winter) and increased bodyweight, whereas lameness and back asymmetries had a negative effect (Greve and Dyson 2015a). The lighter the rider relative to the horse, the greater the changes. Showjumpers had smaller changes in back dimensions and greater frequency of back asymmetries than horses competing in other disciplines. Survey data indicate that in the UK about a third of riders have their saddles checked annually (Greve and Dyson 2015b) but Dr Dyson suggested that, based on the frequency of back shape changes in their study, saddle fit should be evaluated several times a year.

Not only does the horse's back shape change during the course of a year, back dimensions also differ before and immediately after exercise (Greve and Dyson 2014b). Greater increases in back width occur in sound horses compared with lame horses and when the horse is ridden by a more skilled rider. A saddle that fits correctly at the start of exercise may become tight and potentially restrictive during and immediately after exercise.

Professor Emerita Hilary Clayton from Sport Horse Science, Michigan, USA concluded the morning session with a talk that reviewed some new research on rider technique and described how the sophisticated technology used in research laboratories is being adapted to provide simple, inexpensive equipment that can be used by riders, trainers and veterinarians to record, analyse and store information

***Fig 3:** A crooked rider will have a huge influence on the forces transmitted via the saddle to the horse's thoracolumbar region. a) The rider's right shoulder and elbow are lower than the left. The left leg is drawn up and back. b) The rider is sitting to the left with concavity of the right side of her body. The right leg is drawn up and backwards. c) The rider is tipping forward to the right with her weight shifted to the left*

describing horse and/or rider performance. The examples she presented are Coach's Eye <http://coachseye.com/>, the Smart Ride Balance Sensor <http://www.equi-sens.com/> and the Level Belt Pro app from Perfect Practice Pro <http://perfectpracticeusa.com/>.

Coach's Eye is a simple, inexpensive app for a smart phone or tablet used to record, manipulate and analyse videos. It uses tools such as split screen display of 2 synchronised videos to compare different horses or monitor one horse over time. The easy-to-use video drawing tools are similar to those used to highlight aspects of athletic performances on television. Key moments can be viewed repeatedly with precise video scrubbing and slow-motion playback. Feedback can be given immediately after a performance or the video can be stored indefinitely with retrieval of archived videos being facilitated by the tagging, sorting and search functions. This type of software has many veterinary applications for evaluating movements of horse and rider, storing the data and for sharing videos when seeking a second opinion.

The Smart Ride Balance Sensor is a portable electronic training system worn by riders to provide real-time feedback about their balance and symmetry in the saddle. It consists of a pad instrumented with dozens of sensors and enclosed in a neoprene pouch that fits into a special pair of breeches. The breeches come in multiple sizes and are worn over the rider's normal outer wear. The sensor pad continually measures force exerted on the saddle by the rider and sends the information to a controller containing a microprocessor, rechargeable battery and all of the supporting circuitry necessary to process signals from the sensor pad. The controller fits into a pocket on the breeches on the outside of the rider's thigh where it is out of the way of the reins, whip, etc. It processes thousands of signals per second from the sensor pad and computes the location of the rider's centre of force. This information is conveyed to the rider through a pair of vibrating buzzers placed inside the rider's waistband. When activated they feel like a cell phone on vibration mode. The controller unit also contains a super bright indicator light that provides a visual signal. If the rider exerts more force on the right side of the sensor pad, the right buzzer vibrates and the light on the controller is red. If the rider exerts more force on the left side, the left buzzer vibrates and the light on the controller is green. If the rider's weight is symmetrical on the left and right sides, both buzzers vibrate and the light on the controller is blue. After riding with the balance sensor riders become more aware of their weight distribution and symmetry. Dr Clayton emphasised that measurements should be made with the saddle centred on the horse's back and with the girth tightened. The sensor pad must also be centred under the rider's seat so the centre seam of the breeches aligns with the middle of the rider's body. The sensors cannot compensate for horses that move asymmetrically or are lame, or for saddles that slip to the side or are built asymmetrically.

The Level Belt Pro app works on a smart phone or iPod to help athletes improve their core strength and control by providing instant feedback about movements of the pelvis and/or the trunk. It uses the inertial sensor inside the phone that changes the orientation of the display when the phone is rotated. The app applies this sensor to detect when the person wearing it leans forwards/backwards (anterior/posterior tilt) or sideways (lateral lean). The company offers a neoprene Level Belt with an attached holder for the phone to secure it around the rider's pelvis or chest. After warming-up the horse and tightening the girth, the sensors are zeroed prior to starting data collection. It is important for the horse to stand squarely on level ground and the rider to sit in a neutral position when zeroing the device because the subsequent measurements are made relative to the zero value. A buzzing sound informs the rider when the pelvis or the trunk is tilted forwards/backwards or is leaning to the left or right sides by more than the chosen amount (6, 8 or 10°). The Level Belt Pro records the angles continuously throughout each trial and the values can later be downloaded. In addition to using it while riding, the Level Belt Pro can be used in the gym to monitor thoracic and pelvic stability during core training.

The afternoon session was chaired by John McEwen, BEF Director of Equine Sports Science and Medicine. The talks covered several aspects of the horse-saddle-rider interaction starting with a description of the kinematics of the equine thoracolumbar spine by Professor Christian Peham, Leader of the Movement Science Group, University of Veterinary Medicine, Vienna. He traced the progression of research on the horse's back from anatomical and kinematic studies of cadavers (Townsend *et al.* 1983; Townsend and Leach 1984) through static and dynamic kinematic analysis of live horses (Faber *et al.* 2001), to modelling studies (Groesel *et al.* 2010). Some of the kinematic studies of the horse's back have been based on bone-fixed markers to avoid errors that arise when the skin slides over the underlying bones (Faber *et al.* 2001). An alternative method that uses inverse kinematics to overcome the drawbacks of the use of skin markers for spinal kinematic analysis in horses was described (Zsoldos *et al.* 2010a). Professor Peham also talked about the development of spinal models based on research data and the future role of motion analysis as a diagnostic aid in horses with back problems. He pointed out that most of the published work on spinal kinematics has been performed in sound horses and there is a lack of information from horses known to have back pathologies. It will be necessary to evaluate information describing kinematics, forces and muscle activity from sound horses, lame horses and horses with back problems before motion analysis can be applied diagnostically. Given the necessary background data and methodological improvements, motion analysis may become a useful clinical tool for the diagnosis of back problems (Zsoldos *et al.* 2010b).

Professor Lars Roepstorff, Department of Veterinary Anatomy and Physiology, Swedish University of Agricultural Sciences introduced the topic of the influence of the rider, which is certainly recognised as playing a role in the horse's locomotor health. Considerable attention is being focused on rider asymmetry as a possible cause of lameness although sometimes it is difficult to distinguish whether rider asymmetry makes the horse crooked or vice versa. Professor Roepstorff is currently working with the Lameness Locator, developed at the University of Missouri, which indicates whether the horse is lame and, if so, which limb(s) are affected, the degree of lameness and the phase of the motion cycle that is primarily affected. He is using it in conjunction with a sensor on the rider to evaluate how much the rider affects an existing asymmetry in the horse. After introducing the topic, Professor Roepstorff handed the microphone to doctoral student Maria Terese Engell, who described her studies of the rider and, specifically, how postural defects during standing and walking can affect riding performance. Research in other sports has shown that good posture and body awareness are the foundations for an athlete to develop balance and rhythm. She then outlined her study of riders with foot pronation in which she is comparing how the subjects walk when they are barefoot, wearing running shoes and wearing corrective shoes. She also evaluates the same riders sitting on a special chair and when riding a horse to determine the effect of foot pronation on performance in the saddle.

The effects of saddle design and function, presented by Dr Katja Geser-von Peinen, University of Zurich, explored the effects of different types of saddles in relation to their design characteristics. The solid wooden tree that is typical of a Western saddle is fundamentally different from the spring tree typically found in an English saddle. The traditional beechwood tree has largely been replaced by trees made of synthetic materials that change the physical properties and responses of the saddle. Panels filled with wool, foam or air are an integral part of the English saddle, whereas Western saddles rely on the use of a thick pad to provide cushioning and are built with a curved shape to avoid bridging. When present, the panels of a saddle should distribute the rider's weight fairly evenly over a large area without the presence of pressure points and should allow the horse's muscles to work freely during locomotion. One of the problems in achieving this is that saddles are fitted in a standing posture and the horse's back shape changes during locomotion with a characteristic pressure pattern being recognised for each gait. The most difficult gait for the saddle to accommodate is the rising trot during which the rider's weight shifts substantially with high pressure being exerted during the rise when the stirrups are weighted and the loaded area decreases (**Fig 4**). Dr von Peinen recommends fitting the saddle for the horse in motion rather than for a static position but indicated that different functional tests will be needed to accommodate the requirements of specific sports. Her research has provided guidelines regarding pressure thresholds associated with localised ischaemia and back soreness (Von Peinen *et al.* 2010).

As an alternative to a traditional treed saddle, a treeless saddle may be used and several studies of treeless saddles have been performed. However, it should be appreciated that treeless saddles vary in their construction and incorporation of rigid parts, the degree of flexibility and manner of force transfer to the horse's back. The flocking material affects the interaction with the horse's back. Dr von Peinen favours reprocessed wool as a flocking material because it gives the lowest pressures but has found that foam is good if shaped correctly to fit the shape of the horse's back. Shims are useful to redistribute pressure. Regarding saddle pads, sheepskin may provide some damping of the forces but gel pads have a slow response time so although they are adequate at slow loading rates, they are not at high loading rates.

Following the conference, scientists and industry representatives spent 2 days addressing issues related to the rider, saddle and horse during a research workshop sponsored by Albion Saddlemakers and hosted by the AHT. The topic was *Saddle-fitting Fact, Prejudices and Fiction* and the programme was a mix of presentations, discussions and breakout sessions. Delegates agreed that there had been significant progress since the first workshop, particularly with regard to raising awareness of saddle fit issues in the

***Fig 4:** Rising trot concentrates forces transmitted via the saddle to the horse's thoracolumbar region.*

equestrian community and raising the profile of the SRT. The second workshop focused on the saddle and the need for state-of-the-art techniques and equipment to facilitate improvements in equestrian performance. Scientific study will certainly play a role in moving forward but it was recognised that research must be performed rigorously and be of high scientific quality if it is to be useful. Dr Rachel Murray of the AHT presented a talk that described research principles, different study designs and how research results can be applied to the industry. Her recommendations can be used as guidelines for those preparing and performing research on the rider-saddle-horse interface. After completing a research study, one of the researcher's roles is to interpret their scientific data and present it in a way that it is meaningful to the different sectors of the industry. This translation from research to practice is an essential step in the process.

Industry representatives Gerry van Oosanon (Master Saddle Fitting Consultant Society), Mark Fisher (Society of Master Saddlers) and Sue Carson (Sue Carson Saddles) addressed some of the issues from the perspective of the saddle industry including the training, qualifications and oversight of saddle fitting professionals. Approximately half of the members of the Society of Master Saddlers (SMS) are qualified saddle fitters which requires attendance at a 2 day Introductory Saddle Fitting Course at which candidates are taught to perform an assessment of the horse under static and dynamic conditions. This is followed by at least 3 years' of experience in the field with access to a qualified fitter to perform saddle adjustments and attendance at a 4 day Certification Course. However, it is difficult to meet the criteria to join the SMS. Many of the people performing saddle fitting in the field are not members of the SMS and do not necessarily adhere to the SMS standards. Originally, the SMS was formed because of the craft-based nature of the trade but the trade has changed substantially and it was acknowledged that changes in the industry require changes in its regulation. The industry suffers from the fact that it does not have a single governing body to provide guidelines for saddle fitters, oversee training, ensure quality control and educate the public as to what they should expect from a saddle fitter. At the present time several of the larger saddle manufacturers have their own training programmes, but there appears to be enthusiasm among some saddle fitters to come under one umbrella and work together, though inevitably there would be resistance from those who fail to meet the criteria of a new organisation. Delegates were keen that the SRT should pursue this further in collaboration with the industry as a whole.

There was considerable discussion, both at the conference and during the workshop, as to how often saddle fit should be evaluated. The comfort of the horse is, of course, the main concern but the expense of frequent saddle fit evaluations and reflocking should also be considered since this may deter some people. The consensus was that owners could be taught to perform a basic saddle fit evaluation on their own horses through one-on-one instruction or remote learning, such as web-based tutorials, so that they can recognise when to bring in a professional saddle fitter.

A talk from physiotherapist Tim Pigott emphasised the need for riders to think of themselves as athletes and to realise that riding is not enough to maximise their performance in the saddle. Strength training, yoga, Pilates and stability work were recommended to improve physical fitness together with adherence to general principles of exercise physiology such as warming up before mounting. The importance of rider symmetry was emphasised both in the presentation and discussion that followed. Sometimes the rider may be the source of a horse's back pain so it is important to include assessment of the rider in the equation.

Dr Katja Geser-von Peinen described manual assessment of saddle fit and the value of pressure testing. Her talk included comparison of different types of pressure sensors (capacitive, resistive) used in saddle pressure mats and other technical aspects of pressure measurement in addition to a description of clinical signs of saddle problems.

On the final day of the workshop topics of discussion included functional saddle design from the perspectives of horses, riders and manufacturers. Clearly, the tools currently available are inadequate to assess saddles and saddle fit objectively and the development of more effective measurement tools was given high priority. However, loading of the horse's back is a complex issue and multiple measurement methodologies may be required to evaluate the different parts of the horse, saddle, and rider interaction. Anne Bondi discussed how the design and fit of saddles has been based on tradition rather than objective, scientific, peer-reviewed evidence and called for the development of an all inclusive system of training and qualification where saddle fitters, regardless of the saddle type and the manufacturer they work with, should be able to work towards vocational, industry-wide standards. She explained how an open access qualification could be developed with progressive levels of saddle fitter qualifications and a structured continuing professional development programme to raise standards across the industry.

The group had considerable discussion after a second presentation by Anne Bondi on the thorny topic of how much weight it is reasonable for a horse to carry (**Fig 5**). She stressed that there is an urgent practical need for guidelines that address the ridden horse's ability to perform a given task without harm. However, she also demonstrated that loading is a complex and multi-factorial issue, by discussing the factors that must be taken into account, i.e. the horse (height, weight, conformation, fitness, soundness); rider (weight, fitness, symmetry, balance, postural control, health issues); activity (type of work, intensity, duration, footing, terrain); saddle (load-bearing area, fit, suitability) and locomotor ability. Some of these factors can be measured objectively but due to the complex interactions between them, delegates agreed it would be a mistake to recommend a maximum weight to be carried based solely on bodyweights of the horse and rider. Professor Roepstorff suggested it might be possible to create a smartphone app that would help to indicate a horse's ability to perform the required activity without harm based on inputs describing the factors listed above.

In conclusion, we know more about the horse-saddle-rider interface than we did 2 years ago but there are still many unanswered questions. The researchers dispersed with renewed enthusiasm for their studies and with the promise of bringing new findings to the third SRT Conference and Workshop.

Authors' declaration of interests

No conflicts of interest have been declared.

***Fig 5:** The rider is too big for the saddle so is sitting on the back of the seat of the saddle. a) In walk the rider is in adequate balance. b) In trot the rider's lower leg is too far forward so that her shoulder,* **tuber coxae** *and heel are not in a straight line. The rider is therefore out of balance and her rising rhythm was asynchronous to the horse's trot rhythm. A large rider out of balance is potentially much more detrimental to a horse than a large rider who is in balance*

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