HOW TECHNOLOGY CAN QUANTIFY THE IMPACT SADDLES HAVE ON PERFORMANCE

Thanks to advances in technology, it is getting easier for scientists to study horses in a training environment. This, combined with recent saddlery developments in other disciplines, is leading to significant progress in the design and fit of exercise saddles.

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Back pain, muscle tension and atrophy are common issues in yards. Although there are many contributory factors, the saddle is often blamed as a potential cause. Unlike other equestrian sports, where the effect of tack and equipment on the horse has been investigated, until now there has been little evidence quantifying the influence of exercise saddles.

New era

The technological advances used in sport horse research are sparking a new era in racing, enhancing our understanding of the physiological and biomechanical demands on the horse, and helping improve longevity and welfare. For the trainer this translates into evidence-based knowledge that will result in marginal or, in some cases, major gains in terms of a horse's ability to race and achieve results. Race research has always been problematic, not least due to the speed at which the horse travels. Studies have previously been carried out in gait laboratories on treadmills, but this is not representative of normal terrain or movement. Thanks to new measuring techniques, we can now study the horse in motion on the gallops. Evidence of this new era arises from a recent study published in the *Journal of Equine Veterinary Science*. It found areas of high pressures under commonly used exercise saddles which had a negative influence on back function, affecting the horse's gallop and consequently performance.

The pressure's on

Researchers used a combination of pressure mapping and gait analysis (see Technology in focus panel) to investigate three designs of commonly used exercise saddles: full tree, half tree and three-quarter tree. The aim was to identify pressure magnitude and distribution under each of the saddles then to establish whether the gait (gallop) was improved in a fourth saddle designed to remove these pressures.

Areas of high pressure were found in the region of the 10th-13th thoracic vertebrae (T10-T13). Contrary to popular belief, none of the race exercise saddles tested in this study produced peak pressure on or around the scapula. The pressures around T10-T13 at gallop in the half, three-quarter and full tree were in excess of those detected during jumping or dressage in sport horses. They were also higher than pressures reported to be associated with clinical signs of back pain. Therefore, it is widely accepted that high pressures caused by the saddle could be a contributory factor to back pain in horses in training.

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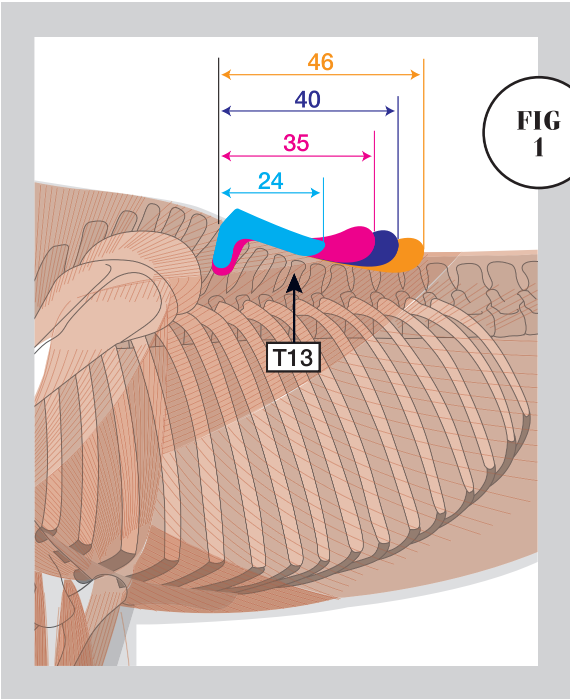


FIG 1

Fig 1: Three most commonly used saddle-tree lengths, plus the new design (purple 40cm)

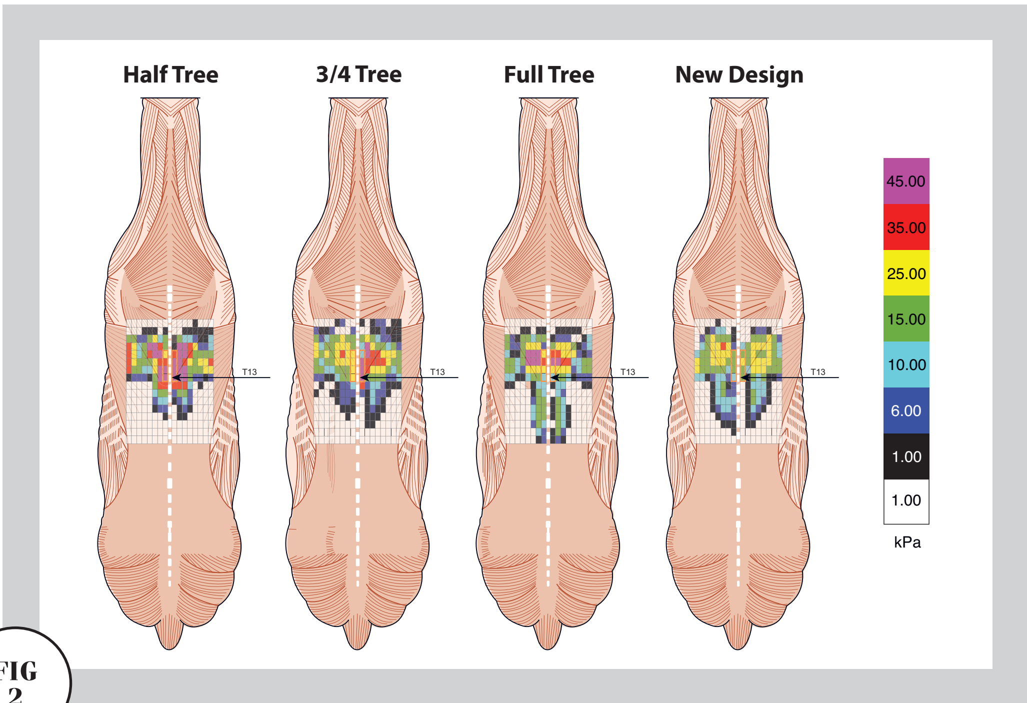


FIG 2

Fig2
Half tree: High peak pressures in the region of T10-T14 were consistent with the end of the tree.

Three-quarter tree: Peak pressure was localised on one side of the back at a time, depending on the horse's gallop lead.

Full tree: Peak pressure was further back and, although not high, gait analysis demonstrated a reduction in the extent to which the hindlimb comes under the horse, reducing the power in the stride.

New design: A more uniform pressure distribution, recording the lowest peak pressures at each location.

Fig 3: A greater femur-to-vertical angle indicates that the hindlimb is being brought forward more as the horse gallops.

Fig 4: A smaller hip flexion angle denotes the hip is more flexed, allowing the horse to bring his quarters further under him and generate increased power.

Lower pressure leads to longer strides

When looking at propulsion, there are two important measurements: the angle of the femur relative to the vertical and hip flexion. When pressures were reduced beneath the saddle, researchers saw an increased femur-to-vertical angle in the hindlimb and a smaller hip flexion angle (denoting the hip is more flexed).

When pressure is reduced in the region of T13, the hindlimb is allowed to come more horizontally under the horse at this point in the stride, leading to an increase in stride length. Researchers speculate that this could be due to the fact that the thorax is better able to flex when pressure is reduced.

Perhaps surprisingly, the study found that reducing saddle pressures did not result in any significant alteration in the forelimb at gallop. The major differences were recorded in hindlimb function. This could be explained anatomically; the forelimb is viewed as a passive strut during locomotion, whereas the hindlimbs are responsible for force production.

This is consistent with findings in the sport horse world, where extensive research investigating pressures in the region of the 10th-13th thoracic vertebrae has shown that reducing saddle pressure is associated with improved gait features in both dressage and jumping.

Speed matters

High speeds are associated with higher vertical forces beneath the saddle: it has been shown that a 10% increase in speed at walk increases pressures under the saddle by 5%, and in trot the figure rises to 14%. Figures for canter or gallop have not been recorded but pressures under exercise saddles were significantly higher than in dressage or jumping, despite the jockey being in a standing position and having a lower centre of mass compared to most other equestrian athletes. Plus, race exercise saddles are lighter than those in other disciplines. These findings support the theory that the higher pressures seen in gallop are due to forces created by an increase in speed.

At walk, with the addition of a rider, the forces on the horse's back are equivalent to the rider's body mass. At trot, this becomes equivalent to twice the body mass, and two-and-a-half times at canter. In gallop, the horse's back is experiencing a higher range of motion than in any other gait; so if the saddle induces high pressures or limits this movement, it will undoubtedly compromise the gallop. The speed in this study was standardised so that any alterations in pressure distribution would be directly attributed to the saddle and not to alterations in ground reaction forces.

Efficiency of stride

Horses in training spend most of their time in an exercise saddle. As each loading cycle causes joint wear and tear, if a new design of exercise saddle can help the horse achieve a longer stride length, this would mean fewer strides are necessary to cover any given distance. A study has suggested that horses have a maximum number of gallop strides in them before they fail, so any reduction in stride quantity (loading cycles), could potentially reduce injury risk.

Compared to work, when racing, the saddle pressures are higher still. A study in 2013 looking at pressures under race saddles identified peak pressures on the

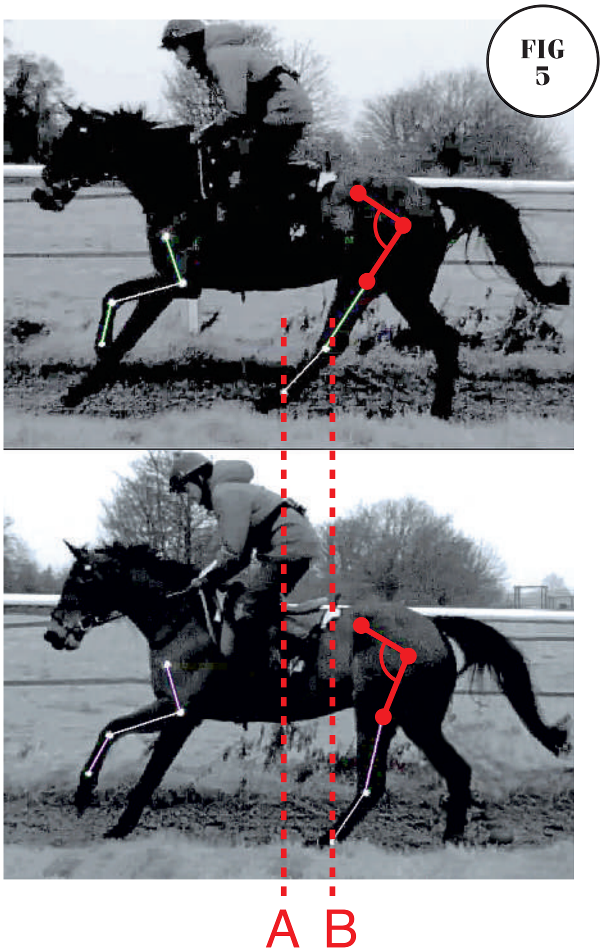


Fig 5: Improved hip flexion was recorded in the new saddle design (A) compared to a commonly used saddle (B).

Fig 6: Technology enables pressure to be recorded under the saddle at gallop.

Fig 7: Peak pressure location zone T10-T13]

spinous processes of the actual vertebrae. These pressure-sensitive bony prominences are not evolved to withstand pressure and are less equipped than the surrounding muscles to do so. Spinal clearance is, therefore, an important consideration.

Pressure pads

All saddles tested in the recent research achieve spinal clearance by means of panels separated by a channel. However, in an attempt to alleviate spinal pressure and make one saddle fit many horses, it's standard practice to use multiple pads under an exercise saddle. This is counterproductive as it can lead to saddle instability. In galloping race horses, forward or backward slip is an issue, and this could be attributed to the use of pads. In addition, too much bulk under the saddle puts a feeling of distance between the horse and jockey.

Tack and equipment form one part of a multi-factorial approach to training, and it is an area that, until now, has been largely overlooked by the scientific community. From studies such as these we have a better understanding how relieving saddle pressure at the base of the withers (T10-T13) allows the long back muscles to transfer propulsive forces from the hindlimb, creating increased power and stride length, and how poor saddle fit compromises performance.

The best we can do is to strive to ensure that performance gains are optimized in all aspects of training. The saddle is, at last, an area where design developments have shown their merits in improving performance and welfare, based on proven scientific results. T

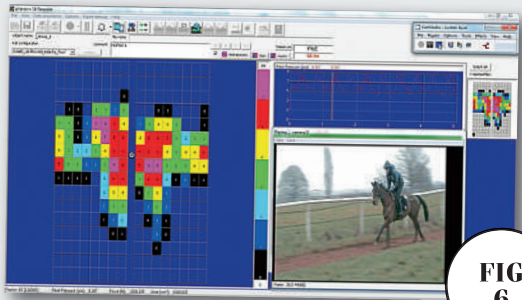


FIG 6

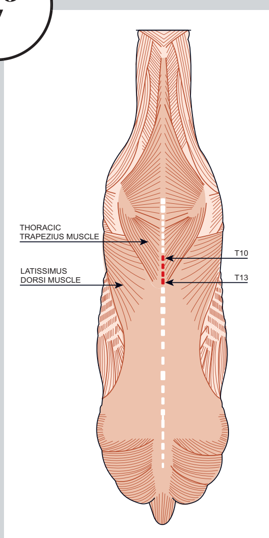
TECHNOLOGY IN FOCUS

Pliance pressure mapping uses a large pressure mat beneath the saddle. The mat has 128 individual pressure sensor cells on each side of the spine. Pliance has been used extensively in research to measure the pressures under the saddle and it can be used in all gaits, including gallop and jumping. Initially the results are displayed as a moving colour-coded image, with areas of peak pressure showing as pink and red. For the statistical analysis, peak pressures, maximum force and mean force are extracted and processed.

Biomechanical gait analysis uses skin markers placed on the horse at the centre of key joints, and the horse is then videoed in gallop at a rate of 300 frames a second—approximately 25 times faster than the human eye. The data quantifies changes in the horse's joint and limb angles allowing any differences in movement to be determined. Using these state-of-the-art measuring systems and robust protocols removes the subjectivity and bias about the extent of any changes a jockey might think they can feel.

The combination of pressure mapping and gait analysis allows researchers to see whether relieving pressure has a direct affect on the horse's limb function.

FIG 7



ANATOMY & SYMMETRY

The area at the base of the wither (around thoracic vertebrae T10-T13) is the location of a high concentration of muscle activity related to posture and movement.

The Longissimus dorsi (m. longissimus dorsi) is a stabilizing muscle that's most active at T12, and spinal stability is essential for the galloping thoroughbred.

In gallop, the forelimbs have to support two-and-a-half times the horse's body weight with every stride. This is an incredible feat, bearing in mind that the horse has no collarbone, and the forelimbs are attached to the trunk by the thoracic sling musculature. Add in the fact that there's a significant intestinal mass pulling down on the spine, and it's easy why spinal health is so important. Any compromises in this area will impact performance.

When compromises such as high pressures occur, horses adopt a compensating strategy. They'll still perform but will develop a gait that alleviates discomfort caused by, in this case, ill fitting or uncomfortable tack. If they are forced to adopt this gait every day, they are likely to increase their asymmetries, leading to asymmetric forces, potentially resulting in poor performance and increased risk of injury.

In fact, all species are asymmetric to some extent: 90% of thoroughbreds were found to prefer galloping on the right lead; and gallop is an asymmetric pace in itself, so pressures will already be asymmetric.

However, the aim is still to produce an ambidextrous animal that can withstand the demands of training. So, as trainers, we have to encourage horses to work symmetrically. Equipment that creates high pressure and causes a compensatory gait hinders this.

Further reading

Could pressure distribution under race-exercise saddles affect limb kinematics and lumbrosacral flexion in the galloping racehorse?
J Eq Vet Sci 81(2019) 102795

Electromyographic activity of the longissimus dorsi muscles in horses during trotting on a treadmill
American Journal of Veterinary Research 65 (2004) 155-158

Back pathology in racehorses
Equine back pathology, Wiley Blackwell, UK (2009), pp. 213-222

Applied load on the horse's back under racing conditions
Vet J, 198 (2013), pp. e88-e92

Girth pressure measurements reveal high peak pressures that can be avoided using an alternative girth design that also results in increased limb protraction and flexion in the swing phase
Vet J, 198 (2013), pp. 92-97

A bridle designed to avoid peak pressure locations under the headpiece and noseband is associated with more uniform pressure and increased carpal and tarsal flexion, compared with the horse's usual bridle
J Equine Vet Sci, 35 (2015), pp. 947-955

Relationship between saddle pressure measurements and clinical signs of saddle soreness at the withers.
Vet J 2010 538 650-3

Saddle pressure patterns of three different training saddles in thoroughbred racehorses at trot and gallop
Equine Vet J 42 (2010) 630-6