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Applied load on the horse's back under racing conditions

Katja Geser-von Peinen[a,*], Selma N. Latif[a], Thomas Wiestner[a], Caroline Bitschnau[a], Brigitte Renk[b]
Michael A. Weishaupt[a]

[a] Equine Department, Vetsuisse Faculty, University of Zurich, 8057 Zurich, Switzerland
[b] 5B Allée Ormes, 60300 Avilly-Saint-Léonard, France

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ABSTRACT

With the intention of limiting the weight on horses' backs and guaranteeing maximal freedom of movement, commonly used racing saddles are small and have minimal cushioning. Poor saddle cushioning may limit performance or even affect soundness of the back. The aim of this study was to measure the pressure under an average racing saddle ridden by a jockey at racing speed. Saddle pressure using a medium-sized racing saddle (length 37 cm, weight 450 g) was measured in five actively racing Thoroughbred horses. All horses were trained at the same facility and ridden by their usual professional jockey, weighing 60 kg. The horses were ridden on a race track at canter (mean velocity, V_1 ± standard deviation, SD: 7.7 ± 0.4 m/s) and gallop (V_2 ± SD: 14.0 ± 0.7 m/s). Maximal pressure was 134 kPa at V_1 and 116 kPa at V_2. Mean peak pressure was 73.6 kPa at V_1 and 54.8 kPa at V_2. The maximal total force did not differ between the two velocities and was approximately twice the jockey's bodyweight. The centre of pressure lateral range of motion differed significantly, with excursions of 23 mm at V_1 and 37 mm at V_2; longitudinal excursion was 13 mm for V_1 and 14 mm for V_2. The highest pressure (>35 kPa) was always localised along the spinous processes over an average length of 12.5 cm. It was concluded that racing saddles exert high peak pressures over bony prominences known to be sensitive to pressure.

Introduction

It is commonly accepted that ill-fitting saddles affect the health and performance of horses (Harman, 1999). This awareness has led to changes in saddle construction that have mainly concentrated on English type saddles (Harman, 1999). Back problems in horses can be reduced by improving the quality of saddle panels to achieve a balanced, centred position on the horse and by improving the shape of the saddle tree to reduce high pressure areas on the horse's back (Monkemoller et al., 2005).

Back problems are relatively common injuries in racehorses that affect training and racing (Bailey et al., 1997). There is potential for improvements to be made in the construction of commonly used training saddles (Latif et al., 2010). Almost all research to date has focussed on English saddles (Harman, 1999). The criteria for saddle fitting are similar among all saddle types; therefore the principles applied to the fitting of English saddles can be applied to any saddle, including the assessment and fitting of racing saddles.

When evaluating the fit of racing saddles, several parameters have to be considered. In riding horses, pressure increases with speed within the same gait (Bogisch et al., 2008), as well as from walk to trot to canter (Fruehwirth et al., 2004); therefore, the high speed of racehorses might have an impact on the saddle pressure. In the jockey seat position (when standing in the stirrups), 90% of the rider's weight is concentrated around the withers (Latif et al., 2010), which seems to be the crucial area when fitting saddles, as shown in a retrospective study by von Peinen et al. (2010). For training and racing, most jockeys/work riders have their own saddle, regardless of the fit for the horses they are riding. On the basis of these criteria, and with the awareness of the current construction of racing saddles, we hypothesised that riding saddles exert high pressure on sensitive anatomical structures of the horse.

Materials and methods

Horses and rider

Five clinically sound Thoroughbred racehorses used in this study had a mean age ± standard deviation (SD) of 4 ± 1.5 years (range 2–6 years) and a mean (±SD) height at the withers of 1.65 ± 0.04 m). All animals resided on the same premises and were stabled individually. They were trained by the same trainer and were considered to be 'racing fit'. In all trials, the horses were ridden by the same jockey (B.

* Corresponding author. Tel.: +41 44 6358881.
E-mail address: kvonpeinen@vetclinics.uzh.ch (K. Geser-von Peinen).

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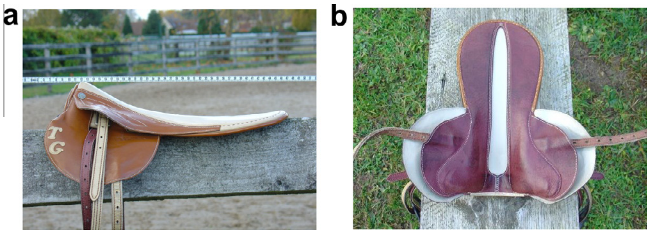

Fig. 1. Racing saddle used in the study, viewed from the side (a) and from below (b).

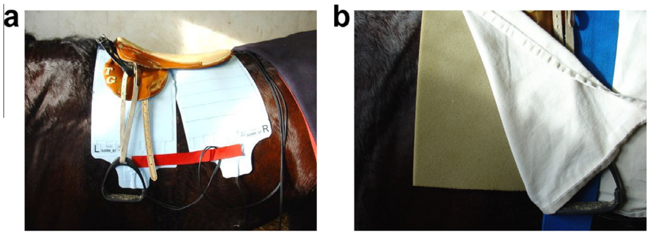

Fig. 2. (a) Placement of the saddle mat in a transverse orientation across the horse's back to measure the pressure on top of the spinous processes. (b) Padding underneath the racing saddle, consisting of a foam pad covered by a thin cotton cloth.

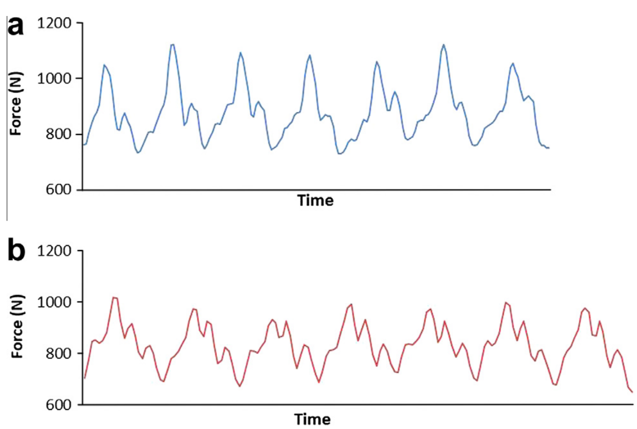

Fig. 3. Total saddle force curves for seven stride cycles of one horse. (a) Canter (V_1: 7.7 m/s, blue line): two force peaks per stride. (b) Gallop (V_2: 14 m/s, red line): four force peaks per stride.

Renk, weight 60 kg) who paid attention to a balanced seat and to consistency in velocities between the trials of each horse. The experimental protocol was approved by the Animal Health and Welfare Commission of the Canton of Zürich, Switzerland (11/2009).

Saddle

The saddle was a commonly used middle sized racing saddle of standard type (Fig. 1). The same saddle was used for all horses. The saddle had a length of 37 cm and a mass of 450 g. The stirrup length was even on both sides and the same for all the horses in all trials.

Data

The exercise protocol was performed on an oval sand training track. Two straight and flat sections of the track, at least 100 m in length, were selected as testing sections. The beginning and end of each section was marked with flagpoles. During the exercise protocol, the testing sections were ridden consecutively without interruption. The first section was ridden at canter and the second section at gallop, both on the right lead and with the rider in a jockey seat. Video analysis

Table 1
Mean values (±standard deviations) of the analysed parameters at the canter (V_1: 7.7 m/s) and gallop (V_2: 14 m/s).

Parameter	V_1	V_2
Velocity (m/s)	7.7 ± 0.4	14 ± 0.7[a]
Stride duration (s)	0.5 ± 0.1	0.4 ± 0.1[a]
Peak pressure (kPa)	134.8 ± 18.7	116.4 ± 15.5[a]
Mean peak pressure (kPa)	73.6 ± 12	54.8 ± 15.7[a]
Total force mean (N)	885.6 ± 45.8	930.3 ± 85.6
Total force maximum (N)	1159.3 ± 76.1	1128.7 ± 93.8
Total force minimum (N)	695.3 ± 46.9	748.2 ± 81.4
Force amplitude (N)	464 ± 47.7	380.6 ± 62.8
Total area (cm^2)	1147.5 ± 106.2	1229.3 ± 189.2
Mediolateral movement: Y COP ROM (mm)	23 ± 3	37 ± 8[a]
Longitudinal movement: X COP ROM (mm)	13 ± 2	14 ± 4

COP, centre of pressure; ROM, range of motion.
[a] Significant differences between V_1 and V_2.

confirmed that V_1 was performed at a three-beat leaping gait, with the leading hind limb and trailing forelimb moving synchronously, while V_2 was performed at a four-beat leaping gait, with the footfalls of the diagonal being dissociated (Barrey et al., 2001). Since saddle pressure measures are sensitive to changes in velocity (Bogisch et al., 2008), speed within horse and gait had to be controlled for repeated measures. Therefore, speed was measured with a G3 W.I.N.D. global positioning sensor (GPS) Sensor (Polar, Electro) and speed information was displayed and recorded continuously on a CS600 Polar watch (Polar Electro). Split times were taken with stop watches as the horse passed the flagpole at the start and end of each section. Proceeding from the first section, and between sections 1 and 2, there was enough distance that the horses could accelerate to the predetermined speed. Measurements were taken when horses travelled at constant speed.

Saddle pressures were measured with a Pliance-X System (Novel). The pressure sensitive mat (Pliance MSA600, Novel) consisted of two separate parts each with 128 sensors in a 16 by 8 (longitudinal by transverse) array. Every sensor had a size of 3.75 × 2.5 cm (9.38 cm^2). On the basis of preliminary measurements, the mat was calibrated to measure a range from 0 to 180 kPa. Since it was to be expected that the saddle would exert pressure on the spinal processes, the two parts of the mat were placed at a right angle to the horse's backline, covering the spinal column (Fig. 2a). The mat was set to zero base line before saddling and tightening the girth. As used in daily training, a rectangular foam pad (thickness 0.8 cm) combined with a rectangular cotton cloth was placed between the pressure sensitive mat and the saddle (Fig. 2b). As commonly used for safety reasons, an over girth was attached over the saddle. At the beginning of each trial, the stop watches, the recording watch of the GPS system and the data logger of the saddle pressure measuring system were started simultaneously.

Data analysis

On the basis of the split times and the velocity information, the saddle pressure data of each sector were extracted from the continuous recordings. The following parameters were analysed using Pliance-x Expert Software11.3.5: (1) peak pressure: maximum pressure of one sensor attained during the entire measurement period; (2) mean peak pressure: mean pressure of the chosen sensor averaged over the entire measurement period; (3) total force mean: sum of the sensors averaged over the entire measurement period; (4) total area: sum of all loaded sensors (without a threshold).

To analyse the maximal and minimal force, as well as the force amplitude and the range of movement, of the jockey's centre of pressure (COP) in lateral and longitudinal directions, time strings were exported into Excel (Microsoft). The maxima were estimated as the 99th percentile and the minima as the first percentile; ranges were calculated by subtraction of the first percentile from the 99th percentile.

For the respective track sections, the mean velocities (m/s) and mean stride durations were determined. Mean sector velocities were calculated with the Polar Pro Trainer Equine Edition software (Polar Electro).

Statistical analysis

Statistical analysis comparing the variables at the two different speeds were performed using using a paired *t* test with SigmaStat 3.5 (SPSS). The data were checked for normality using a Holm–Sidak test. The level of significance was set at $P < 0.05$.