Journal of Equine Veterinary Science 54 (2017) 60–69

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Original Research

Reducing Peak Pressures Under the Saddle Panel at the Level of the 10th to 13th Thoracic Vertebrae May Be Associated With Improved Gait Features, Even When Saddles Are Fitted to Published Guidelines

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A R T I C L E I N F O

Article history:
Received 9 November 2016
Received in revised form 27 February 2017
Accepted 27 February 2017
Available online 6 March 2017

Keywords:
Biomechanics
Equine
Saddle
Gait analysis
Pressure mat

A B S T R A C T

Saddle–horse interaction is increasingly linked with back pain, performance, and welfare issues. Saddle fit and work quality influence alterations in back shape with exercise at thoracic vertebra 13 level (T13) with exercise. The objectives of experiments were to: determine a repeatable zone and stride point of peak pressure under saddles fitted to industry guidelines; compare peak pressure in this zone and limb kinematics in collected trot between horses own saddles (S) and a saddle designed to reduce pressure at T10–T13 (F); compare thoracolumbar width change after exercise between S and F and with F after 3 months use. Elite dressage ($n = 13$) horses/riders with no lameness/performance problem had pressure mat data acquired under S, fitted by four qualified saddle fitters, to determine zones of peak pressure. Pressure mat data at T10–T13, forelimb/hindlimb protraction, and carpal/tarsal flexion acquired using simultaneous high-speed motion capture, and difference in thoracolumbar dimensions (T8, T18 at 3, 15 cm) between before and after exercise was compared between S and F. Peak pressures were consistently detected axially around T10–T13 (sensors A4–A7, H4–H7). Peak pressures were significantly less with F than S for each cell and pooled (55%–68% difference. $P = .01$ to $<.0001$). Saddle F was associated with 13% greater forelimb and 22.7% hindlimb protraction, 3.5° greater carpal and 4.3° tarsal flexion ($P = .02$ to $.0001$), and greater increase in thoracolumbar dimensions after exercise ($P = .01$ to $<.0001$). Saddles fitted to published guidelines may still have a nonideal interface with horses. Reducing peak pressures around T10–T13 was associated with improved limb kinematics in trot and greater thoracolumbar expansion after exercise.

1. Introduction

Saddle–horse interaction is increasingly recognized as associated with back pain, poor performance, and welfare issues [1–4]. Recent studies have shown that alterations in back shape under the saddle at thoracic vertebra 13 level (T13) with exercise were influenced by saddle fit and work quality [5]. Back width after ridden exercise increased when horses were ridden more correctly, in better fitting saddles and with a more skilled rider. A relationship between muscle development scores and back kinematics during sitting trot has been reported [6]. Better abdominal,

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0737-0806/$ – see front matter
http://dx.doi.org/10.1016/j.jevs.2017.02.010

thoracic, and lumbosacral musculature were associated with improved thoracolumbar and lumbosacral flexion and greater elevation of the withers relative to the tuber sacrale, which is likely to influence back shape and pressure under the saddle [6]. However, how posture, gait, and saddle pressure are related has not previously been investigated.

The horse's back moves in three planes: flexion/extension, lateral bending, and axial rotation, which are likely to affect pressure patterns under the saddle. At trot, maximal back flexion occurs during the swing phase, whereas maximal extension occurs during the stance phase when the forelimb and diagonal hindlimb are load bearing [7–9]. It might therefore be expected that there would be certain repeatable points in the stride where the pressure under the saddle in the midthoracic region would be maximal.

Postural control during exercise is managed by a balance between the back extensors, which moderate flexion (longissimus dorsi, intercostalis, gluteus medius) and the back flexors which moderate extension. As collection increases, there is increased flexion of the limbs and elevation of the thorax relative to the pelvis. The rectus abdominis, external abdominal oblique, pectorals, and thoracic serratus ventralis lift the thorax and abdomen and flex the thoracolumbar and lumbosacral regions [10–12]. It has previously been shown that girth pressure at the junction of various muscles involved in retraction and movement of the forelimb and flexion of the thoracic and lumbar regions was associated with alteration in gait and posture [13]. Following this pattern, it is possible that excessive pressure over the muscles in the thoracic region could also be having an effect on movement.

We hypothesized that A (1) there will be a repeatable zone of peak pressure under standard saddle panels and (2) the zone of peak pressure will occur at a repeatable point in the stride; and B (1) reducing peak pressures at this high pressure zone will improve stride kinematics and (2) reducing peak pressures will improve thoracolumbar posture. The objectives of experiment 1 were to: (1) objectively determine a repeatable zone of peak pressure under saddles fitted to Society of Master Saddler (SMS) guidelines; (2) determine the point in the stride when there is maximum peak pressure in this zone. Experiment 2: (1) compare peak pressure in the high pressure zone and limb kinematics between the horse's own saddle (saddle S) and a saddle designed to reduce peak pressure (saddle F) at T10–T13 in collected trot; (2) compare the change in thoracolumbar width before and after exercise between saddle S and F. Experiment 3: compare the change in thoracolumbar width before and after exercise in saddle F after 3 months use of saddle F, with findings in experiment 2.

2. Materials and Methods

Thirteen elite dressage horses (nine geldings, two stallions, and two mares; age range 8–16 years; height 162–175 cm) competing internationally at small and big tour level and four elite professional male and three female riders were used for the study. All horses were on a regular program of veterinary management and physiotherapy and were deemed fit and without lameness. The study was approved by the ethical review committee of the Animal Health Trust (14/2016, approval date February 11, 2016), and there was informed owner consent. All horses were ridden by their usual rider.

2.1. *Experiment 1: Assessment of Position Under the Saddle and Timing in the Stride of Peak Pressure Under Standard Saddles That Have Been Fitted to SMS Guidelines*

Saddles on 13 horses that had been fitted to SMS guidelines [14] were used for the study. All saddles had been regularly assessed by qualified saddle fitters prior to the study and were the usual saddle used by each horse.

All horses had templates of the thoracolumbar shape recorded prior to exercise and immediately following exercise, using a flexible curve ruler (Blundell Harling 600 mm) with the horse standing square on a hard, level surface, following the SMS guidelines [5,14]. This information was used for the design of saddle F in experiment 2.

Four qualified registered SMS saddle fitters independently assessed the fit of saddles on 13 horses. Saddles were included in the assessment process after ruling out structural faults (including loss of integrity of the tree) and confirming that the panel flock or foam was in good condition. Every saddle was assessed by all four saddle fitters independently, following the SMS criteria for fitting saddles under static and dynamic conditions (Table 1). Saddle fit was assessed in a straight line and on a circle in walk, trot, and canter on both reins. Saddle position and presence or absence of saddle movement in medial–lateral, dorsal–palmar, and cranial–caudal planes were recorded.

2.1.1. *Data Collection*

Pressure mat data were acquired under the panel either side of the gullet of the saddle using a pressure mat (600 mm long and 200 mm wide for left and right side, 256 sensors long and 256 sensors wide arranged in 16 columns and 8 rows for each of left and right sides) (Sensor Elastisens MSA600, Pliance, Novel gmbh) (sampling rate 50 Hz) positioned under the saddle. The pad is divided into

Table 1
Society of Master Saddlers criteria for fitting saddles under static and dynamic conditions [14].

Assessment Type	Criteria	Classification for Horses 1–13
Static	Fit of tree width and shape	Correct
	Saddle length	Correct
	Saddle design	Correct
	Panel pressure	Correct
	Balance of saddle	Correct
	Clearance of spine and withers	Correct
	Position of girth straps in relation to conformation	Correct
Dynamic	Lifting at the back	Not visible
	Movement side to side	Not visible
	Slipping to one side	Not visible
	Movement forward/backward	Not visible
	Negative effect on rider's position	Not visible
	Negative effect on horse's normal way of going	Not visible

Four saddle fitters independently assessed all the saddles included in the study.