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The Veterinary Journal 173 (2007) 578–584
The Veterinary Journal
www.elsevier.com/locate/tvjl

The influence of the width of the saddle tree on the forces and the pressure distribution under the saddle

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Accepted 1 February 2006

Abstract

As there is no statistical evidence that saddle fit influences the load exerted on a horse's back this study was performed to assess the hypothesis that the width of the tree significantly alters the pressure distribution on the back beneath the saddle. Nineteen sound horses were ridden at walk and trot on a treadmill with three saddles differing only in tree width. Kinetic data were recorded by a sensor mat. A minimum of 14 motion cycles were used in each trial. The saddles were classified into four groups depending on fit. For each horse, the saddle with the lowest overall force (LOF) was determined. Saddles were classified as "too-narrow" if they were one size (2 cm) narrower than the LOF saddle, and "too-wide" if they were one size (2 cm) wider than the LOF saddle. Saddles two sizes wider than LOF saddles were classified as "very-wide". In the group of narrow saddles, the pressure in the caudal third (walk 0.63 N/cm$^2 \pm 0.10$; trot 1.08 N/cm$^2 \pm 0.26$) was significantly higher compared to the LOF saddles (walk 0.50 N/cm$^2 \pm 0.09$; trot 0.86 N/cm$^2 \pm 0.28$). In the middle transversal third, the pressure of the wide saddles (walk 0.73 N/cm$^2 \pm 0.06$; trot 1.52 N/cm$^2 \pm 0.19$) and very-wide saddles (walk 0.77 N/cm$^2 \pm 0.06$; trot 1.57 N/cm$^2 \pm 0.19$) was significantly higher compared to LOF saddles (walk 0.65 N/cm$^2 \pm 0.10$/ 0.63 N/cm$^2 \pm 0.11$; trot 1.33 N/cm$^2 \pm 0.22$/1.27 N/cm$^2 \pm 0.20$). This study demonstrates that the load under poorly fitting saddles is distributed over a smaller area than under properly fitting saddles, leading to potentially harmful pressures peaks.

Keywords: Saddle fit; Kinematics; Kinetics; Pressure; Saddletree

1. Introduction

Most horses in the industrialised world are ridden and this has an important influence on the animals' musculoskeletal health. However, despite this fact, objective evaluation of saddles, and of their influence on the horse, is lacking. As Harman (1999) has stated, saddles are sold with little consideration of fit and even less knowledge about the consequences of poor fit.

Saddles differ in a number of variables, including the length and width of the tree, the padding surface and the angle of the lateral parts of the tree. Poor saddle fit has been found to cause back pain (Jeffcott et al., 1999), which can result in poor performance and lead to an enormous wastage of horses in all ridden sports, economic losses, and consequent abuse to the animals as their value decreases (Harman, 1999).

In most cases, saddles are only evaluated subjectively in the standing horse. Even though experienced saddlers can often select a suitable saddle, such evaluations cannot be reproduced reliably by veterinarians or owners. Use of a saddle pressure pad is an objective method for determining pressures on the equine back both in the standing horse and during movement when pressures increase. In earlier studies using a sensor pad under the saddle, Frühwirth et al. (2002) found that the total force transmitted via the saddle pad at walk was correlated closely to the rider's body mass and that in trot the total force was about twice the force at walk. From these findings, questions arose about the influence of saddle fit on the total force transmitted via the saddle pad and on the distribution of pressures under the saddle.

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1090-0233/$ - see front matter
doi:10.1016/j.tvjl.2006.02.005

In the human literature, Le et al. (1984) have shown that the pressures on the muscle tissue are transmitted to the bone surfaces below, and that at the level of the bone the pressures are significantly higher than at the level of the skin. Thus, pressures are not only relevant to muscle function and to the comfort of the horse, but are also relevant to the health of the spine. Additionally, Todd and Thacker (1994) showed that human skin necrosis starts close to the bone before reddening of the skin and ulcerations occur. Even though equine skin necrosis under the saddle caused by pressure appears to be rare in horses, with the vast majority apparently caused by friction, an effect of increased pressure on the tissues close to the spine can be inferred.

The aim of the present study was to assess the hypothesis that the width of the tree significantly alters the pressure distribution on the equine back beneath the saddle, using three similar saddles with different tree widths in horses at the trot and at the walk.

2. Materials and methods

2.1. Horses

Nineteen adult horses, four mares, two stallions and 13 geldings, aged 4–22 years (mean 10.3 ± 4.8 years) were used for this study. Mean body mass was 521.4 ± 70.2 kg and mean height at the withers was 1.61 ± 0.079 m. Back examination and routine orthopaedic examination was carried out to confirm that the horses were sound and had no clinical signs of back pain (Jeffcott, 1979).

All experiments were approved by the Ethical Board for Animal Experiments (Ethik-und Tierschutzkommission) of the University of Veterinary Medicine, Vienna.

2.2. Rider

The same rider (male, body mass 80 kg) was used for each trial in the light of the findings by Jeffcott et al. (1999) that there is a linear relationship between the rider's body mass and the pressures under the saddle. Additionally, Peham et al. (2001) documented a correlation between the skill of the rider and the consistency of motion of the ridden horse.

2.3. Saddles

The three dressage saddles (Symphonie) used in the study were produced by the same saddlery company (Niedersüß) and were similar except for tree width. The narrow saddle (N) had a cranial tree width of 28 cm, the medium saddle (M) had a cranial tree width of 30 cm, and the wide saddle (W) had a tree width of 32 cm. The saddles were assessed in a Latin square design study.

2.4. Data collection

Measurements were carried out on a treadmill (Mustang 2200, Kagra). After a minimum of two unridden training sessions on the treadmill, the horses were trained to be ridden on the treadmill in at least two additional training sessions. For each horse, one suitable speed was chosen, which was initially found by varying the speed of the ridden horse on the treadmill until the rider confirmed that a rhythmical trot was possible without the constant use of rider's aids. In order to standardise the measurements, all three saddles were then measured at that same treadmill speed.

The kinetic data were recorded via pressure measuring pad (Pliance System, Novel) placed under the saddle at a sampling rate of 30 Hz. The pressure pad consisted of 224 sensors arranged in 14 columns and 16 rows. The pad was divided into two distinct halves fastened together with adhesive tape. In the middle of the pad, directly above the midline of the horse, the pad had no sensors. The saddle pad was covered with neoprene, and no other padding was used, allowing for direct contact between the measuring pad and the skin and hair coat below as well as the leather of the saddle surface above.

Prior to measuring, the pad was calibrated to zero after placing the saddle on the horse and tightening the girth. At the walk and trot, 20 s recordings were made with each saddle, resulting in a minimum of 14 walking motion cycles and 22 trotting motion cycles.

2.5. Data processing

Motion cycles were separated using synchronous kinematic data of the left fore hoof.

2.6. Classification of saddles

The saddle with the lowest overall force (LOF) was determined by summing the forces of all 224 sensors at the walk and trot separately. At every measured time step (sample), the sum of all segment forces was calculated, and then the time series over the mean motion cycles of all saddles were compared. The saddle with the significantly lowest sum of overall force at walk and at trot was defined as the saddle with the lowest overall force. Saddles with a tree one size narrower than the LOF saddle were classified as 'too-narrow'; saddles with a tree one size wider were classified as 'too-wide', and saddles with a tree two sizes wider were classified as 'very-wide' for each individual horse.

2.7. Analysis of results

Because force and pressure depend on speed and probably on the motion pattern of the horse, only intra-individual comparisons were possible. As a result of the classification, we made eight comparisons between fitting and too-narrow saddles (LOF = M or W: comparisons M–N and W–M); 16 comparisons between fitting and too-wide saddles (LOF = N or M: comparisons N–M