Quantitative comparison of pressure distribution exerted by different numnahs beneath the saddle of a ridden horse

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Introduction Equine lameness and back pathologies are significant welfare issues and may be linked to saddle-fit during ridden exercise. Previously 74.3 % of animals presenting orthopaedic back pathology were shown to be concurrently lame and conversely, 41.1 % of horses diagnosed with primary lameness exhibited back pathology (Landman *et al*., 2004). Meschan *et al.,* (2007) defined optimum saddle fit as those that transmitted lowest overall force and distributed force without generating pressure peaks. Incorrectly fitting saddles exert pressure peaks, for example overlying the *longissiums dorsi* in the caudal third of the contact. Numnahs are soft, cushion structures placed beneath the saddle to help dissipate the pressure of the saddle and rider over the horse's back, away from the spinal area. They have been demonstrated to increase overall back pressure in a qualitative preliminary study (Harman, 1994). The present study determines quantitatively the effect upon pressure distribution between different numnahs using a pressure sensor mat.

Materials and methods Four geldings (horses 1 to 2; 15 years, range 13 to 20 y) of different breeds and height (154 cm, range 151.2 to 161.2 cm) with no recent history of back pain were used. Horses were maintained on a daily ridden exercise programme, a regular shoeing regimen and had an annual teeth check by a veterinary surgeon. The experiment was performed on a single day. One experienced rider (weighing 69 kg) rode all horses. Back pressure data were recorded from each horse walking a figure of eight pattern twice on a uniformly concrete floor. The numnahs used were a standard saddle cloth, poly pad, sheepskin, half sheepskin, gel pad or ridden bareback. A randomised 4 x 6 design was used so that each horse was measured wearing each numnah. A general purpose saddle was placed on top of the numnah. A pressure mat (PX100 model, Xsensor Technology Corporation Calgary, Canada) was placed beneath the numnah and saddle. The pressure mat consisted of 2400 individual piezo-electric sensors in a 60 x 40 grid pattern. Each sensor generated an individual reading every 1/8 second. The pressure mat was connected to a hand-held data logging computer. The mean, minimum and maximum pressures were calculated for each sensor on the pressure mat. Sensors which did not contact the saddle or numnah and thus received no pressure measurement were excluded from the data set giving a final grid of 52 x 36 sensors for all calculations. ANOVA was used to compare pressure between horses and within horse between numnah, for each sensor. Resulting P-values generated for each sensor in the grid were designated a colour to identify areas which were significantly different at either $P<0.05$, $P<0.01$ or $P<0.001$. These analyses were performed for mean, maximum and minimum pressure data.

Results All horses when ridden bareback showed areas of peak mean pressure upon the back occurred away from the spine but pressure of 20,000 - 40,000 mmHg were concurrently applied directly to the spine (Figure 1). When ridden in a saddle and numnah the areas of peak mean pressure lay away from the spine (30,000 to 40,000 mmHg) and pressure exerted directly on the spinal area was low (0 to 10,000 mmHg; the lowest pressure category; Figure 2). These observations were also true when considering maximum and minimum pressure values. Horse-dependent variation was apparent; a number of sensors were significantly different between horses, even when lowering the significance value to $P\leq0.001$ (Figure 3). Fewer sensors showed a significant difference in a numnah-dependent manner (Figure 4); however, almost all areas which showed significantly different values of $P \leq 0.001$ were adjacent to the spine.

Figure 1 Mean pressure distribution exerted upon the back when ridden bareback, using horse 1 as an example

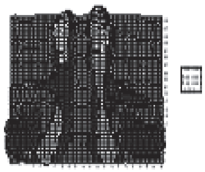

Figure 2 Mean pressure distribution exerted upon the back when ridden in a standard saddle cloth, using horse 1 as an example

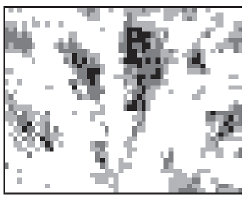

Figure 3 Areas of significantly different mean pressure between 4 ridden horses (■ $P<0.05$, ■ $P<0.01$,■$P<0.001$)

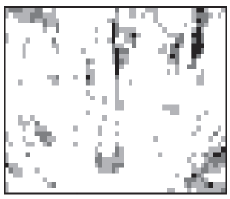

Figure 4 Areas of significantly different mean pressure between 5 numnahs (■ $P<0.05$, ■ $P<0.01$,■$P<0.001$)

Conclusions The present study quantitatively demonstrated that the saddle and numnah dissipated pressure away from the spine compared to bareback riding. Some areas of the back exhibited pressure variation between numnahs but the effect of horse resulted in more areas of variation illustrating the importance of fitting saddlery specifically to an individual animal, rather than relying on a 'one type fits all' application of numnahs and/or saddles. The quantitative use of pressure sensor mats enables accurate assessment of the equine back; software to improve statistical analysis would further aid interpretation and pave the way for further studies. The interpretation of between-horse back pressure variation requires further research

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