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Comparative measurements of surface body temperature of horses using infrared thermography

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Abstract

Infrared thermography is a painless, non-invasive method that can be used to improve the physiological assessment and health of the horse, and as an alternative, or in combination with other imaging methods and diagnostic procedures. The main advantage of thermography is the detection of subclinical signs of inflammation before the onset of clinical signs of pathology. The aim of this pilot study was to determine the surface body temperature of six clinically healthy horses in indoor conditions. The horses` bodies were laterally scanned on the left and right sides and were divided into the following regions: neck, shoulder, thoracic limb, back, thigh and pelvic limb. The abdominal region of the horses was scanned individually in ventral projection. The average temperature of each region was calculated. An approximately equal thermal symmetry was observed between both sides of the horse's body.

Keywords: horse; infrared thermography; non-invasive; surface temperature

Introduction

Infrared thermography was introduced in 1965 and has since an important role in equine sport and veterinary medicine (Soroko et al., 2013). Thermography is a painless, non-invasive method that can be used to improve the physiological assessment and health of the horse (Turner, 1991; Redaelli et al., 2014; Čebulj-Kadunc et al., 2020). The main advantage of thermography is the detection of subclinical signs of inflammation before the clinical signs of pathology. Thermography is several times more sensitive to heat than human hand palpation and can detect slight changes in body surface temperature (Turner, 2001; Soroko et al., 2013). This method is also useful in the diagnostics and prognosis of a variety of limb injuries, including laminitis, navicular syndrome, inflammations of the fetlock joints, and of carpal and tarsal joints (Purohit and Mccoy, 1980; Turner, 1991; Soroko-Dubrovina and Morel, 2023). Thermography can be used in the diagnosis of back injuries, recovery from neurological disease (von Schweinitz, 1998; von Schweinitz, 1999; Tunley and Henson, 2004), and monitoring the effectiveness of anti-inflammatory drugs (Purohit, 2008; Čebulj-Kadunc et al., 2020). It can also be as a potential screening for the detection of illegal substances used at competitions and to define the welfare of horses (Turner, 1991; Eddy et al., 2001; Čebulj-Kadunc et al., 2020). Another important role of the use of thermography is to determine how the saddle fits and if the rider is balanced or imbalanced on the saddle (Arruda et al., 2011; Soroko et al.2019). It is incorrect to consider that thermography replaces other diagnostic techniques but should be used as a diagnostic method, complementary to

standard clinical examinations, such as radiography, ultrasonography, tomography, and magnetic resonance imaging (Turner, 2001; Redaelli et al., 2014; Čebulj-Kadunc et al., 2020).

Materials and methods

The aim of this study was to determine the surface body temperature of clinically healthy horses in indoor conditions. The study was carried out on six horses between the ages of 7 and 20, including one stallion, three geldings, and two mares, with body weights between 450 and 530 kg. The rectal temperature of all six horses ranged from 37.4 to 38.1 °C. The pulses rate and breathing were also normal. Clinical examination shows no injuries or illnesses at this time.

The body surface temperature was measured using an infrared camera *Thermovision XP* (*Laserliner, Germany*). The thermal camera was set to an emissivity of 0.98. Thermography measurements were taken in a stable with an ambient temperature of 16°C. The horse's bodies were laterally scanned on the left and right sides and were divided into the following regions: neck, shoulder, thoracic limb, back, thigh and pelvic limb. The imaging distance was about 6-7 meters. The distal thoracic and pelvic limbs were additionally scanned from a distance of approximately 1-1.50 meters in palmar and plantar as well, as lateral and medial aspects. The abdominal region of the horses was scanned individually in ventral projection. Infrared radiation was presented as an individual thermogram, where the color gradient corresponds to the distribution of surface temperatures. The software used for image analysis was Quick Reporting-Editor.

The analysis and statistical processing of the data were performed by the computer program SPSS 19.0. The mean statistical values of the surface body temperature in the scanned regions, respectively, on the left and right sides of the horses, were calculated. The data is expressed as mean plus standard error. In this study, the assessment is made with a guaranteed probability of 0.95 (significance level $\alpha = 0,05$), where $p < 0,05$ was adopted as the lowest level of statistical reliability.

Results

The average thermographic parameters showed distribution symmetry of body surface temperatures on the left and right sides in the six horses. Results showed a slight increase in mean body surface temperatures on the left side of the

Table 1. Average parameters (°C) of body surface temperatures in six healthy horses.

anatomic region	side	N	Mean	Std. Error Mean	Minimum	Maximum	Variance
neck	left	18	29,18	0,367	25,28	31,50	2,418
	right	18	28,91	0,294	26,48	30,46	1,551
shoulder	left	18	29,24	0,401	26,32	32,04	2,900
	right	18	29,04	0,302	26,23	31,15	1,641
thoracic limb	left	18	27,40	0,398	24,18	30,53	2,854
	right	18	27,04	0,391	23,33	29,42	2,749
back	left	18	27,30	0,494	24,30	30,74	4,389
	right	18	26,84	0,446	24,35	30,10	3,578
thigh	left	18	27,53	0,540	24,08	31,38	5,255
	right	18	27,28	0,484	24,47	30,23	4,225
pelvic limb	left	18	27,20	0,397	24,01	29,67	2,844
	right	18	26,34	0,397	23,81	29,24	2,841
abdomen	ventral	18	27,35	0,601	24,11	30,92	6,498

horses body with no statistically significant differences (table 1).

On the left side of the horses' body, the highest average body surface temperatures were measured in the shoulder (29.24±0.401°C), followed by the neck region (29.18±0.367°C). An approximate decrease of 2°C was observed in the mean temperatures in the back (27.30±0.494°C) and thigh (27.53±0.540°C) regions (fig.1). The lowest mean temperatures were measured in the distal limbs: thoracic (27.40±0.398°C) and pelvic (27.20±0.397°C), respectively (fig. 1).

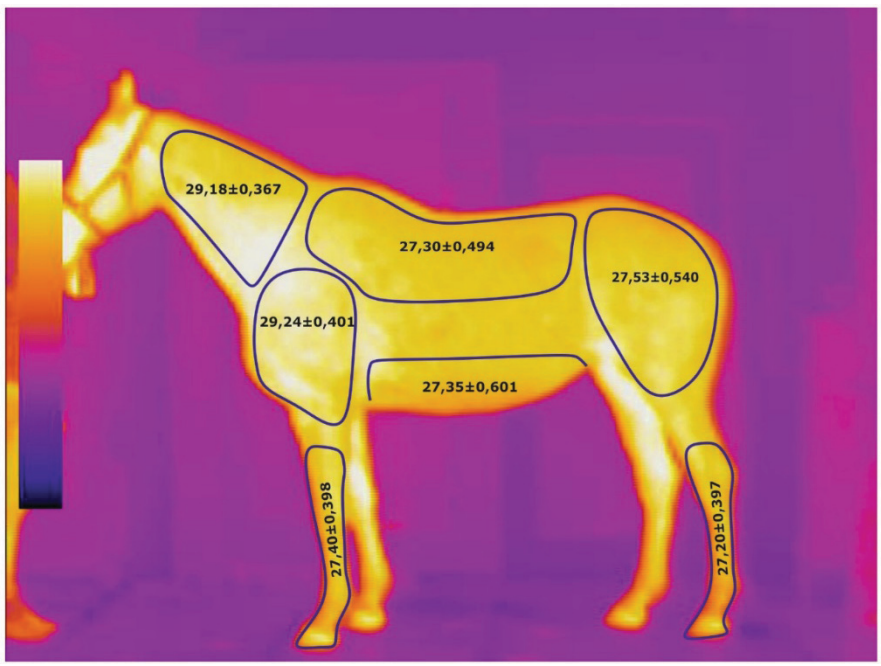

Figure 1: Distribution of mean body surface temperatures on the left side of horses.

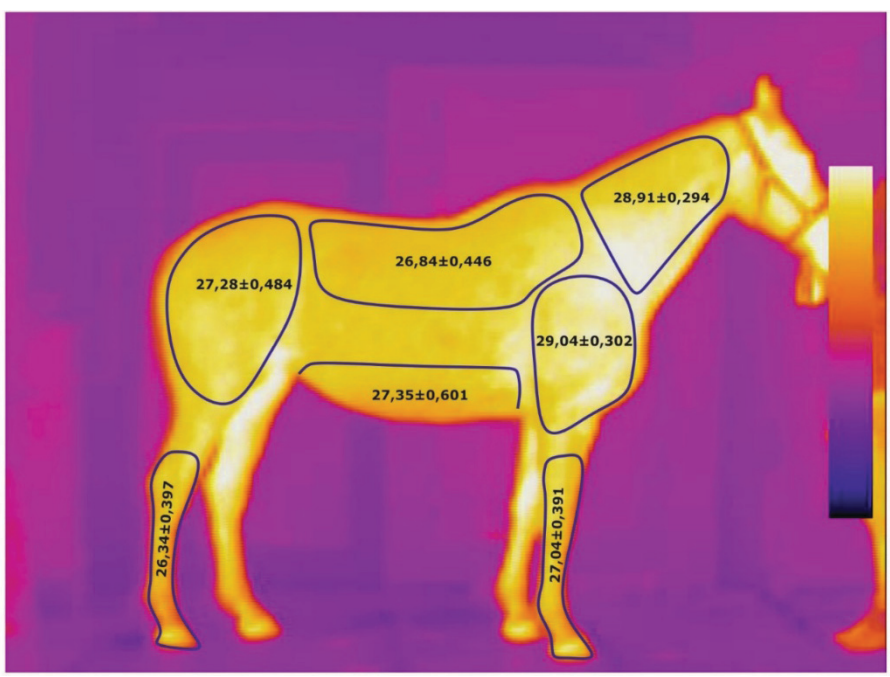

Figure 2: Distribution of mean body surface temperatures on the right side of horses.

On the right side of the horses' body, the highest mean body surface temperatures were also measured at the shoulder (29,04±0,302°C), and neck (28,91±0,294°C), followed by the back (26,84±0,446°C) and thigh (27,28±0,484°C) regions (fig.2). Similar to the lower mean distal limb temperatures measured on the left side, the same areas on the right side were also colder. Mean temperatures measured on the right side of the distal forelimb (27.04±0.391°C) and hindlimb (26.34±0.397°C) were in the same range (fig. 2).

The mean surface temperature of the abdominal region (27.35±0.601°C) was slightly lower compared to the values of the neck and back, similar to that of the back, thigh, and the distal parts of the legs on the left and right side (fig. 1, 2).

Discussion

The results obtained from this study were consistent with other data describing the use of infrared thermography in horses placed under similar conditions. Each horse has its own individual thermographic pattern, which is related to vascular and tissue metabolism and is influenced by ambient air temperature (Čebulj-Kadunc et al., 2020; Soroko-Dubrovina and Morel, 2023). Measurements of the highest surface body temperatures on the neck, shoulder, back, and thigh were reported by other authors (von Schweinitz, 1999; Jodkowska et al. 2011; Čebulj-Kadunc et al., 2019; Soroko-Dubrovina and Morel, 2023). These areas of the body of the animal are characterized by higher metabolic activity and this suggests a higher body surface temperature (Simon et al., 2006; Čebulj-Kadunc et al., 2020). Large vessels located in these areas, such as the jugular vein and brachial plexus, are associated with high vascular activity, creating additional opportunities for higher body surface temperature. Veins are generally warmer than arteries as they are located in metabolically active areas and more proximal to the skin surface (Soroko-Dubrovina and Morel, 2023). The regions of the neck, shoulders, and thighs also are characterized by massive skeletal muscles and have a higher surface temperature, compared to less muscular areas, such as the distal limbs from the carpal or tarsal joints to the hoof (Jodkowska and Dudek, 2000; Čebulj-Kadunc et al., 2020). The presence of subcutaneous tissue in these areas also increases the body surface temperature, as it absorbs heat from deeper-lying blood vessels (Soroko-Dubrovina and Morel, 2023).

The lowest body surface temperatures were registered in the distal parts of the thoracic and pelvic limbs, where tendons predominated, and where there is a low blood supply. In this study, individual measurements of these distal limbs showed increased values in the coronary band area. According to Turner et al. 2001, it is due to the presence of arteriovenous plexus in this region. However, the average results confirms the data of a slightly-decreased surface temperature in distal limbs, compared to surface temperature in the other examined regions in healthy horses at rest (Simon et al., 2006; Jodkowska et al., 2011; Redaelli et al., 2014; Čebulj-Kadunc et al., 2020; Soroko-Dubrovina and Morel, 2023).

Conclusion

Infrared thermography of the six healthy horses at rest showed approximately equal bilateral symmetry. The highest average horse body surface temperatures were detected on the neck and shoulders, and the lowest - on the distal limbs.

One of the aims of this pilot study was to verify the technical capabilities of the used equipment to accurately measure the thermographic examination in horses. The results we found encourage us to continue to search for more precise and specific research in this field.

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