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Temperature range analysis (T_{max}) on dorsal surface of sporting horses

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Abstract: The aim of this study was to determine temperature differences on the dorsal surface of 32 clinically healthy show jumping horses. Temperature was measured using a Thermovision 550 (FLIR) camera, determining maximum temperature (T_{max}). The horse's body was divided into the following regions: neck, withers, cranial back, caudal back, loins, and hindquarters. Those regions were subdivided into middle, left, and right parts. Statistical methods used for calculations consisted of Wilcoxon's signed rank test and Dunn's post hoc comparison test. Temperatures on the dorsal surface ranged from 19.5 to 31.5 °C, with the lowest indicated in the withers area and the highest in the caudal back and hindquarters area. Temperatures on the sides tended to be symmetrical except for the caudal back region, where the temperature of the right side was higher than of the left side. The data can be used for determination of unfavorable stimulation of the back and loin region by the rider and saddle, as well as for diagnosing conditions that result in increased temperature in the dorsal area.

Key words: Horses, thermography, dorsal body surface, maximum temperatures

1. Introduction

Riding horses, not created to carry the rider's weight by nature, are prone to strains that result in injuries and health problems, particularly in the spine region. Owing to the structure of the horse's spine and the physiology of physical effort, muscles, tendons, and ligaments of this region are subject to various overloads and strains, which influences the scope of biochemical processes in particular tissues. This is related to thermal regulation processes demonstrated indirectly by the body surface temperature. The more intensive processes in the subcutaneous tissues are, the higher the temperature is.

Several authors described temperature of the horse's back, focusing mostly on diagnostic aspects. Recently thermography has been indicated to be useful in identifying and localizing spine injures (1,2). It has helped in localizing the inflammation processes in spinous processes, supraspinous and interspinous desmitis, and intervertebral arthritis of thoracolumbar spine (3).

Changes in perfusion of tissues in the spine area may indicate pathological conditions caused by incorrect use of a horse, mistakes in the rider's seat, and/or a badly fitted saddle (4–7). Jeffcott (8) showed that injuries of paraspinal muscles and stretching of ligaments are diagnosed in 25% of hard-working horses, which predisposes them to these conditions. Other research indicated changes in temperature of the sacroiliac region caused by joint problems typical for show jumping horses, particularly those with abnormalities in movement patterns of the hind limbs (9–11). The aim of this study was to elucidate temperature differences on the dorsal surface of healthy show jumping horses.

2. Materials and methods

Analysis of temperature T_{max} of the dorsal surface was performed on 32 show jumping horses. Thermography measurements were obtained from clinically healthy Polish half-bred horses aged between 8 and 16 years, including 18 stallions, 8 geldings, and 6 mares, with body weight between 450 and 520 kg. Temperature was measured using a Thermovision 550 (FLIR) at the resting state, before exercises. The camera was positioned over the horse, 1.5 m behind the hindquarters at a height of 2.5 m. The dorsal surface was divided into the following regions, which were then subdivided into middle, left (′), and right (″) parts: the neck (1, 1′, 1″), withers (2, 2′, 2″), cranial back (3, 3′, 3″), caudal back (4, 4′, 4″), loins (5, 5′, 5″), and hindquarters (6, 6′, 6″) (Figure 1), where the average of the maximum temperature (T_{max}) was determined, specifying the warmest areas. Minimum temperatures were omitted

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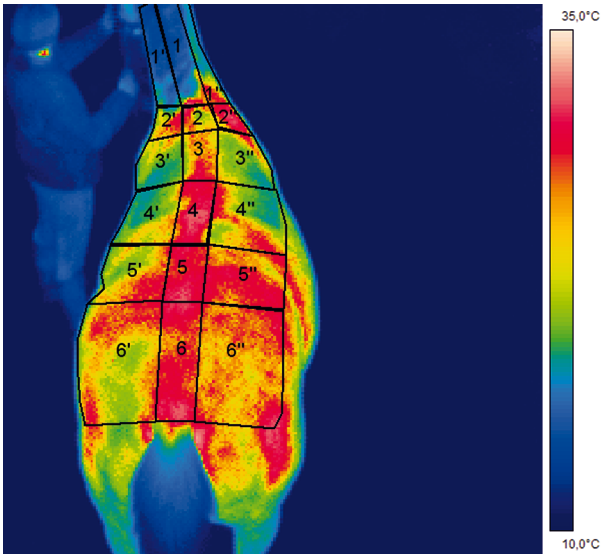

Figure 1. The division of the dorsal body surface (1- neck, 2- withers, 3- cranial back, 4-caudal back, 5- loins, 6- hindquarters).

as not being the subject of this research and error-prone as a result of problems with determining the boundaries of the examined body parts.

The surface temperature data were referred to the features of subcutaneous tissues. Rectal temperature of all horses ranged from 37.5 to 38.2 °C. Clinical examination did not show any injuries or diseases in horses. Thermography measurements were taken in a stable with ambient temperature T_{ab} = 14 °C and relative humidity φ = 60%. Statistical methods of Wilcoxon's signed rank test and Dunn's post hoc comparison test were used.

3. Results

Temperatures (T_{max}) on the dorsal surface of show jumping horses were within the range of 19.5–31.5 °C, with the lowest temperatures in the withers area and the highest in the caudal back and hindquarters (Table 1). The lowest T_{max} temperature of all measured body parts was found on the neck. However, considering that the hair coat of the mane interferes with the surface temperature body distribution, the neck was not included in comparative analysis. The second lowest T_{max} temperature (middle area) was found on the withers, while the highest temperatures were found on the caudal back and hindquarters. The temperature measured along the middle area of the spine was always higher than the temperature on both sides, the differences ranging from 0.6 °C in the loins region to 1.6 °C in the caudal back region. The areas with the highest temperature were warmer than the side surface over the longissimus dorsi muscle, covered in the withers area by the pectoral part of the trapezius muscle. A smaller difference of temperatures was found over the latissimus dorsi muscle with the dorsolumbar fascia. In the hindquarters, the temperature difference between the surface of the sacral bone and its sides increased in the area of the gluteus medius and gluteus superficialis muscles. Both sides of the spine had a symmetrical temperature range, except for the

Table 1. Maximum temperatures (T_{max}) of dorsal body surface of show jumping horses.

No.	Region of interest	Statistic	Part of region			Wilcoxon's test
			Left, T_{max} (°C)	Middle, T_{max} (°C)	Right, T_{max} (°C)	
1	Neck	$\bar{x}$ ± SD	21.3 ± 3.2	20.8 ± 2.1	21.4 ± 2.9	P = 0.886
		x_{min}–x_{max}	16.3–27.7	17.2–25.4	16.2–26.8	
2	Withers	$\bar{x}$ ± SD	26.4 ± 1.8	27.1 ± 1.6	26.5 ± 1.6	P = 0.238
		x_{min}–x_{max}	21.3–30.5	23.4–30.7	22.7–29.9	
3	Cranial back	$\bar{x}$ ± SD	26.2 ± 1.9	27.8 ± 1.7	26.2 ± 1.9	P = 0.899
		x_{min}–x_{max}	19.8–30.3	22.4–31.4	19.5–30.2	
4	Caudal back	$\bar{x}$ ± SD	26.6 ± 2.0	27.9 ± 2.0	26.8 ± 2.0	P = 0.028
		x_{min}–x_{max}	19.7–30.7	21.0–31.5	20.0–30.9	
5	Loins	$\bar{x}$ ± SD	27.0 ± 2.0	27.6 ± 2.2	27.0 ± 2.1	P = 0.607
		x_{min}–x_{max}	19.7–30.8	19.7–31.2	19.7–30.9	
6	Hindquarters	$\bar{x}$ ± SD	26.9 ± 2.0	28.0 ± 1.7	27.0 ± 2.0	P = 0.136
		x_{min}–x_{max}	19.6–30.9	22.5–31.3	19.6–30.9	

caudal spine, with temperatures of the right side higher than those of the left side (Table 1). This was visible especially on the caudal back and loins (Figure 2). Statistically significant differences were determined in temperature ranges of the dorsal surface between the withers and other areas, between the caudal back and loins, and between the loins and hindquarters (Table 2). The surface of the withers was always coldest in comparison to other areas of the spine, while the hindquarters and caudal spine were warmer than the loins in the middle part of the region. The temperature range on the body surface of standing horses can be diagnosed based on thermographs and division of areas into warmer and colder ones according to values of maximum temperatures (T_{max}) that constitute the middle of isotherms of a particular body part.

4. Discussion

Previous research indicated that the lowest temperature values (24.0–26.2 °C) were found on the surface of sides, the pastern, the fetlock joint, and the back of the metacarpus and cranial caudal joint. The highest temperature values (27.5–32.3 °C) were found in the area of the eyes, nostrils, arm, forearm, and elbow, as well as the neck, shoulder blade, loins, flanks, thigh, and shank. It was reported that the warmest areas on the surface of the horse's body are the ones from the hindquarters to flanks (19). The increased perfusion of the caudal back and hindquarters could be related to the greatest mobility of the spine in this region: extending and flexing dorsally and ventrally (12). High temperature in the middle area of the hindquarters can be related to the engagement of the hind limbs in the horse's locomotion. Muscles responsible for the mobility of the spine include the iliocostalis, longissimus dorsi, spinalis, and semispinalis muscles. Both muscle groups, acting on both sides of the spine, are responsible for its sideways movement. Research on paraspinal muscles found that the most important muscle influencing dorsal and ventral flexion of the spine is the longissimus dorsi muscle (13). The same muscle stabilizes the spine in the horse's movement (14). Results of previous research indicated that in horses at rest and after examination, the temperature of the line of the thoracic spine was higher by 3 °C than the temperature of the thoracic spine sides (15). Thermographic analysis consisted in dividing the back horizontally into lines, along which temperatures were measured in the area corresponding to T9 and T12 vertebrae. Similar results were obtained by other authors who found that clinically healthy backs were warmer by 2 °C than the horses' sides (2). Spine build depends on longitudinal and interspinous ligaments that run between the adjacent spinous processes of the vertebrae and supraspinous ligaments that join the dorsal part of spinous processes. They act as a support for spinal processes of the thoracic, lumbar, and sacral spine. These parts of the spine are usually the area of pathological lesions of spinous processes in sport horses (8,16). The proven symmetry confirms findings of earlier publications that showed similarity of temperatures of the left and right sides of a horse's body (17,18). Lack of symmetry in the right side of the caudal back requires additional research conducted on a greater number of horses used in different performances. In other research, temperature of the right side of the horse's back was also found to be higher than that of the left side (19). In a healthy horse, analyzed from both sides, every area on the body surface was ranked according to temperature values in respect to other areas (19).

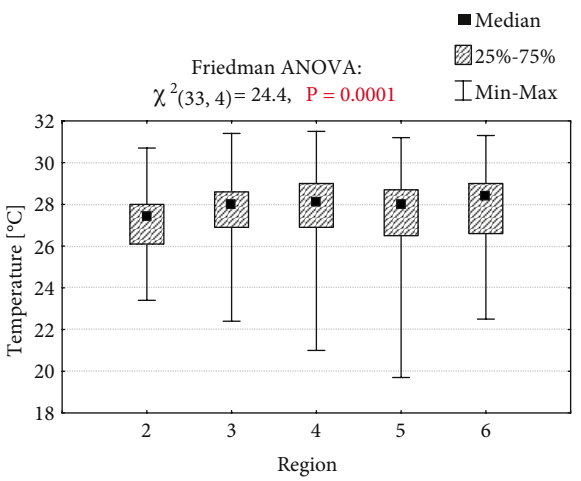

Figure 2. The temperature (T_{max}) of the dorsal body surface (2- withers, 3- cranial back, 4- caudal back, 5- loins, 6- hindquarters).

Table 2. The significance of temperature differences between the selected areas of the body (Dunn's post hoc test).

Region of interest	Cranial back	Caudal back	Loins	Hindquarters
Withers	P < 0.001	P = 0.001	P = 0.046	P = 0.001
Cranial back	-	P = 0.510	P = 0.365	P = 0.688
Caudal back	-	-	P < 0.001	P = 0.588
Loins	-	-	-	P = 0.038

In conclusion, the following points can be listed:

1. Equal ambient temperature during thermographic examinations allows us to conclude that the body surface temperature differences between horses are associated with the horse's individual traits, which should be the subject of further study.
2. The highest body surface temperature on the back and loin in horses at rest can be the result of biomechanical activity of those regions during the examination.
3. Distribution of dorsal body surface temperature on both sides of the spine in healthy horses is symmetrical.
4. Veterinary examination should be indicated if there is any asymmetry of the regions on both sides of the spine, or when there is increase of the body surface temperature in the middle region of the dorsal body surface.

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