THE MAXIMUM TEMPERATURES (T_{MAX}) DISTRIBUTION ON THE BODY SURFACE OF SPORT HORSES

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Objective

The objective of the study was to determine the usefulness of measuring maximum temperatures in designated regions of the body surface of a healthy horse.

Introduction

Horses are homeothermic and eurythermic animals, the amount of heat their organisms produces may vary within broad limits. The temperature at the surface of the horse's body may constitute an indicator of changes in thermoregulation. It is modified by the influence of climatic conditions, effort and diseases.

Methods

Thermographic investigations (Thermovision®550, FLIR) were carried out on 35 horses from 6 to 16 years old that participate in show jumping competitions. The measurements (left and right sides) were made half an hour before the competition (Fig. 1) and immediately after its completion (Fig. 2). The maximum temperature was determined for chosen regions. The rectal temperature of all horses fell within the boundaries of 37.5 – 38.2°C. The ambient temperature (Tab) was 14°C and humidity (φ) was 60%. The results of the research were analysed statistically.

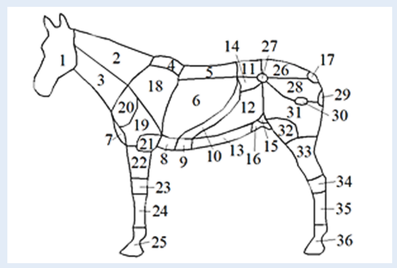
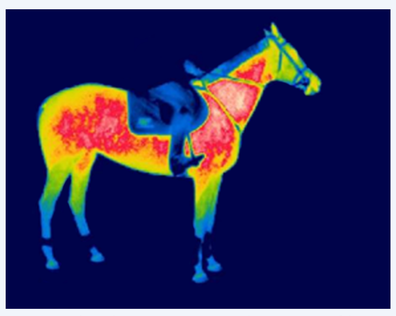


Fig. 1 . Thermogram and regions of horse conformation before competition (explanation in tab. 1)



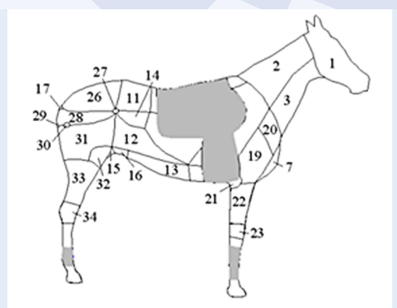


Fig. 2. The thermogram and regions of horse conformation after the competition (explanation in tab. 2)

Results

The maximum temperature of the horses' body surface temperature at rest was from 21.8 °C to 31.0 °C and symmetrical regions did not differ statistically ($p > 0.05$), (Tab.1). The interrelations between the regions in respect of temperature are typical. It is important to compare the temperature of the given region with another region (temperature gradient) rather than the absolute numerical value of one of them.

After the show jumping competition, the range of the horses' body surface temperatures was from 25.2°C to 34.2°C and no statistically significant asymmetry was found between the right and left sides (Tab. 2). The greatest increase in maximum temperature following the competition indicates that these regions play the greatest role in releasing heat from the horse's organism during extreme work.

Table 1. Maximum temperature of body surface before competition

No (ROI)	Region of body surface	Maximum temperature $\bar{T}_{max} \pm S_T$ [°C] Left side	Right side	Test L v. R P-value	Surface cm²	%
1	*Head**	30.8 ± 1.8	31.0 ± 1.7	0.687	1 338	8.3
2	*Dorsal s. of neck*	29.2 ± 2.0	29.8 ± 1.6	0.155	1 313	8.1
3	*Ventral s. of the neck*	29.7 ± 2.4	29.6 ± 1.9	0.809	901	5.6
4	*Withers*	28.9 ± 2.3	29.4 ± 2.3	0.348	228	1.4
5	*Back*	29.1 ± 1.6	29.0 ± 1.3	0.823	487	3.0
6	*Ribs*	30.1 ± 1.3	30.3 ± 1.5	0.606	1 925	11.9
7	Breast	26.3 ± 2.1	25.6 ± 2.2	0.162	82	0.5
8	Fore flank	27.9 ± 2.2	28.0 ± 1.7	0.848	141	0.9
9	Costal cartilage	28.1 ± 2.1	28.0 ± 1.9	0.859	114	0.7
10	*Subribs region*	29.4 ± 1.8	29.6 ± 2.1	0.670	392	2.4
11	Loin	28.3 ± 1.9	28.9 ± 2.4	0.276	258	1.6
12	*Hind flank*	29.5 ± 1.5	30.0 ± 1.3	0.114	923	5.7
13	Abdomen	28.0 ± 1.2	28.1 ± 1.1	0.586	381	2.4
14	*Coupling*	29.6 ± 1.2	29.5 ± 1.0	0.588	160	1.0
15	Sheath	28.8 ± 2.6	28.0 ± 2.8	0.205	34	0.2
16	*Groin*	29.1 ± 3.1	29.2 ± 3.9	0.940	77	0.5
17	*Dock*	30.7 ± 3.2	29.4 ± 4.4	0.166	50	0.3
18	*Shoulder*	30.5 ± 4.2	30.9 ± 3.0	0.580	1 154	7.1
19	*Arm*	29.1 ± 4.1	29.7 ± 3.6	0.528	565	3.5
20	*Point of shoulder*	29.0 ± 4.3	29.9 ± 2.8	0.320	448	2.8
21	Elbow	27.7 ± 3.6	27.1 ± 3.8	0.467	220	1.4
22	Forearm	27.3 ± 5.0	27.2 ± 4.0	0.890	399	2.5
23	Knee	24.9 ± 4.2	24.6 ± 4.2	0.409	162	1.0
24	Cannon	21.8 ± 4.6	22.2 ± 4.0	0.625	255	1.6
25	Digit (phalanx)	26.9 ± 5.1	25.0 ± 4.0	0.082	261	1.6
26	*Croup*	29.1 ± 2.5	29.1 ± 2.0	0.966	453	2.8
27	*Point of hip*	28.5 ± 2.4	29.5 ± 2.1	0.060	45	0.3
28	*Haunch*	29.4 ± 2.7	29.9 ± 2.8	0.513	601	3.7
29	*Point of buttock*	29.8 ± 2.6	30.0 ± 2.3	0.728	42	0.3
30	Trochanter	28.7 ± 3.1	29.6 ± 2.7	0.243	48	0.3
31	*Thigh*	30.2 ± 3.7	30.5 ± 3.1	0.650	1 135	7.0
32	Stifle joint	28.0 ± 3.1	28.5 ± 3.4	0.569	326	2.0
33	Gaskin	26.4 ± 3.4	25.8 ± 3.4	0.517	601	3.7
34	Hock	25.1 ± 3.4	24.9 ± 5.0	0.377	160	1.0
35	Cannon	22.8 ± 5.5	23.1 ± 4.3	0.687	250	1.5
36	Digit (phalanx)	26.6 ± 4.6	27.1 ± 4.5	0.652	254	1.6
	Total				16 183	100.0

**the warmest region*

Table 2. Maximum body surface temperature after the competition

No (ROI)	Region of body surface	Maximum temperature $\bar{T}_{max} \pm S_T$ [°C] Left side	Right side	Test L v. R P-value
1	Head	30.9 ± 1.0	30.9 ± 1.2	0.829
2	*Dorsal s. of neck**	33.9 ± 1.2	33.3 ± 1.2	0.069
3	*Ventral s. of the neck*	34.2 ± 1.5	33.8 ± 1.5	0.311
7	Breast	31.0 ± 1.2	31.0 ± 1.1	0.831
11	Loin	32.4 ± 1.5	32.1 ± 1.9	0.524
12	Hind flank	32.3 ± 1.7	33.1 ± 1.7	0.112
13	Abdomen	30.7 ± 1.9	31.1 ± 1.8	0.530
14	Coupling	32.0 ± 1.4	32.6 ± 1.3	0.066
15	Sheath	32.4 ± 1.0	32.3 ± 1.2	0.765
16	Groin	31.7 ± 1.8	31.6 ± 1.9	0.827
17	Dock	31.2 ± 1.6	31.6 ± 1.3	0.239
19	*Arm*	33.1 ± 0.6	33.1 ± 0.6	0.608
20	*Point of shoulder*	33.2 ± 1.7	32.9 ± 1.8	0.475
21	Elbow	32.4 ± 1.6	32.6 ± 1.7	0.627
22	Forearm	31.6 ± 1.3	31.7 ± 1.3	0.858
23	*Knee*	25.8 ± 1.7	25.2 ± 1.7	0.164
26	Croup	32.4 ± 1.7	31.5 ± 2.1	0.074
27	Point of hip	32.3 ± 2.2	31.9 ± 1.8	0.447
28	Haunch	32.9 ± 1.8	32.3 ± 1.9	0.272
29	Point of buttock	33.2 ± 1.3	33.1 ± 1.6	0.802
30	Trochanter	31.6 ± 1.4	31.7 ± 1.4	0.773
31	*Thigh*	33.1 ± 1.3	32.8 ± 1.8	0.580
32	*Stifle joint*	33.0 ± 1.8	32.6 ± 1.2	0.296
33	Gaskin	31.1 ± 1.8	31.3 ± 1.5	0.602
34	Hock	25.7 ± 1.0	25.9 ± 0.8	0.515

**the warmest region*

The maximum temperatures of the limbs were characterised by a greater standard deviation (s), which points to the thermolability of these regions. As an example, the temperatures of the surface of knee - therolabile (fig. 3) and the point of buttock - thermostabile (fig. 4), were compared. Earlier publications proved the thermostability and thermolability of regions of the body in relation to variable micro-climatic conditions. In this study, this was demonstrated in relation to horses subject to a workload.

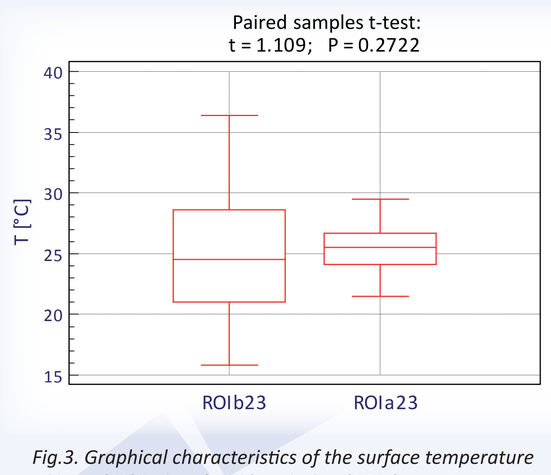


Fig.3. Graphical characteristics of the surface temperature of knee (23) before (ROIb) and after (ROIa) exercise and the result of the student's t-distribution test (difference in temperature 0.8°C statistically insignificant at a level of P > 0,05)

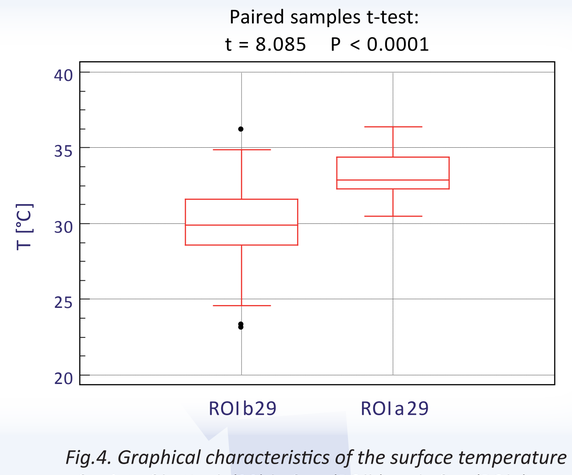


Fig.4. Graphical characteristics of the surface temperature of point of buttock (29) before (ROIb) and after (ROIa) exercise and the result of the student's t-distribution test (difference in temperature 3.2°C statistically significant at a level of P < 0.0001)

Conclusions

1. The choice of maximum temperatures is useful for characterising the distribution of temperatures at the body-surface for diagnostic purposes and for assessing the functioning of particular parts of the body during exercise.
2. The interdependence of regions with maximum temperatures is significant in relation to the musculature of particular areas.
3. Horses are symmetrical as regards body-surface temperature measured from both sides. This means any asymmetry discovered in this regard should be examined by a veterinarian.
4. The graphical distribution of body-surface temperatures is characteristic of all healthy horses regardless of their level of training. However, the temperature level [°C] varies depending on individual characteristics and the impact of the environment.
5. Knowledge of the body-surface temperatures of horses may be useful for planning sports training.