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Diagnostics And Prognosis Of Orthopedic Diseases Of Dogs Using Thermography.

AV Bokarev*, AA Stekolnikov, MA Narusbaeva, VE Gorokhov, and AA Imanbaev.

St. Petersburg State Academy of Veterinary Medicine, 5 Chernigovskaya str., St. Petersburg 196084, Russia.

ABSTRACT

This paper presents materials on the diagnostic and prognostic capabilities of thermography for orthopedic diseases in dogs. The obtained results signify that thermography allows us 1 - to diagnose diseases of inflammatory and neoplasm pathologies; 2 - to examine the state of the muscular system and other soft tissues during the pathology of nerves and blood vessels;3 - to determine the boundary of surgical resection in case of the distal limb necrosis;4 - to monitor the state of the pathological focus in the course of treatment.

Keyword: thermography, orthopedics, distal limbs, lameness.

**Corresponding author*

INTRODUCTION

Lameness is the most obvious symptom of orthopedic disease in animals. The cause of lameness can be various diseases, the diagnosis of which is carried out both by laboratory methods and by methods of visual diagnosis. Apart from widespread methods like ultrasound, X-rays, CT, NMR there is also the method of thermography (TG) which allows us remotely and very accurately to measure and visualize temperature, simultaneously and differentially, at different points of the studied body surface of the animal [1; 2; 3; 4; 5].

However, it should be noted that the method of thermographic research is not yet widespread in the routine practice of veterinary medicine. And its diagnostic and prognostic capabilities are not clearly defined.

Goals and Objectives of the Study: to estimate the diagnostic and prognostic capabilities of the thermographic method of research for orthopedic pathologies in dogs.

Tasks of the Study:

1. using the methods of on-the-off diagnosis to determine the area of the pathological focus on a limb with a violation of the support function;
2. using thermography method to visualize the zones with low or high temperature on the limb with a violation of the support function;
3. using X-ray to check the accuracy of the data obtained by thermography.

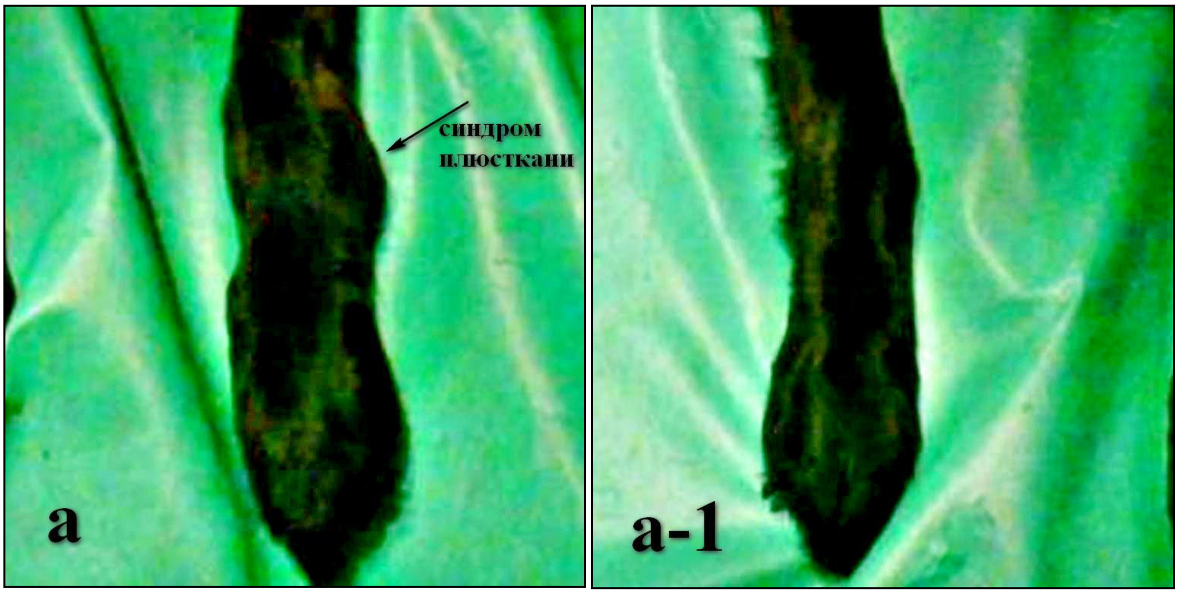
MATERIALS AND METHODS

More than 20 dogs with impaired support function of the limb were examined. Studies were conducted in the clinic of the St. Petersburg State Academy of Veterinary Medicine. Thermographic studies were performed using a **DT-980 thermograph made by "Cem-instruments", China**. The analysis of the obtained thermograms was carried out on a personal computer using the program **IR meter 1.0.6.0.**X-ray examination was performed using a portable x-ray machine **GIERTH HFX 90 V.**

RESULTS

<u>**1 – Support type lameness with the plus tissue syndrome.**</u>

During TG examination of animals having the support type lameness and the plus tissue syndrome (PTS)(Figure1a; Figure 2a), the zone of elevated temperature was visualized in the area of localization of the latter (Figure 1b; Figure 2a-1).



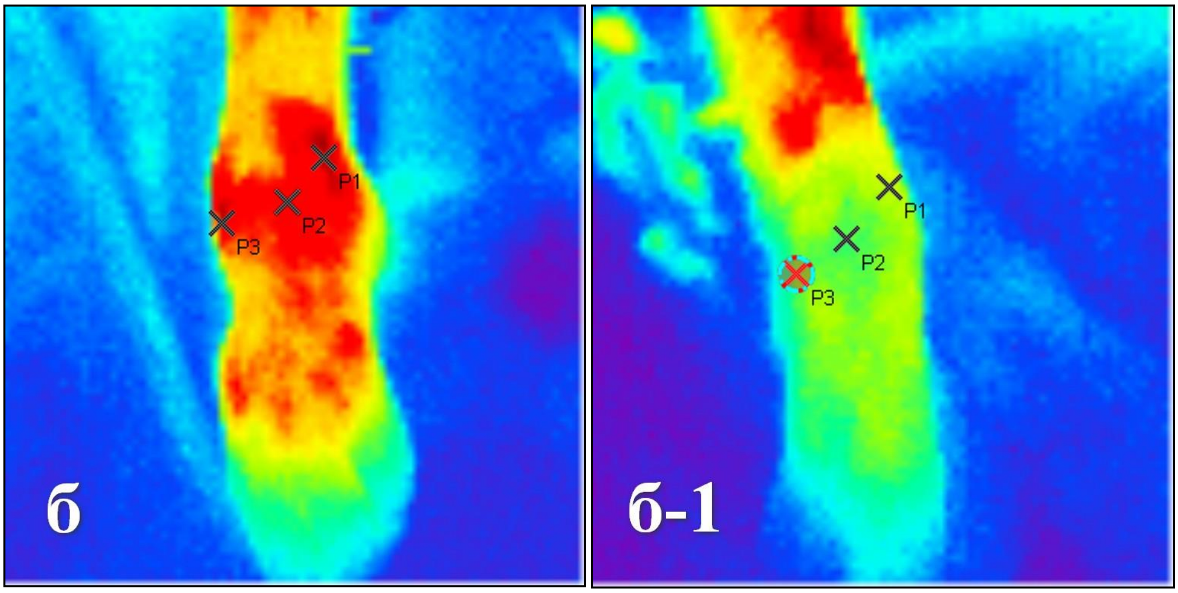
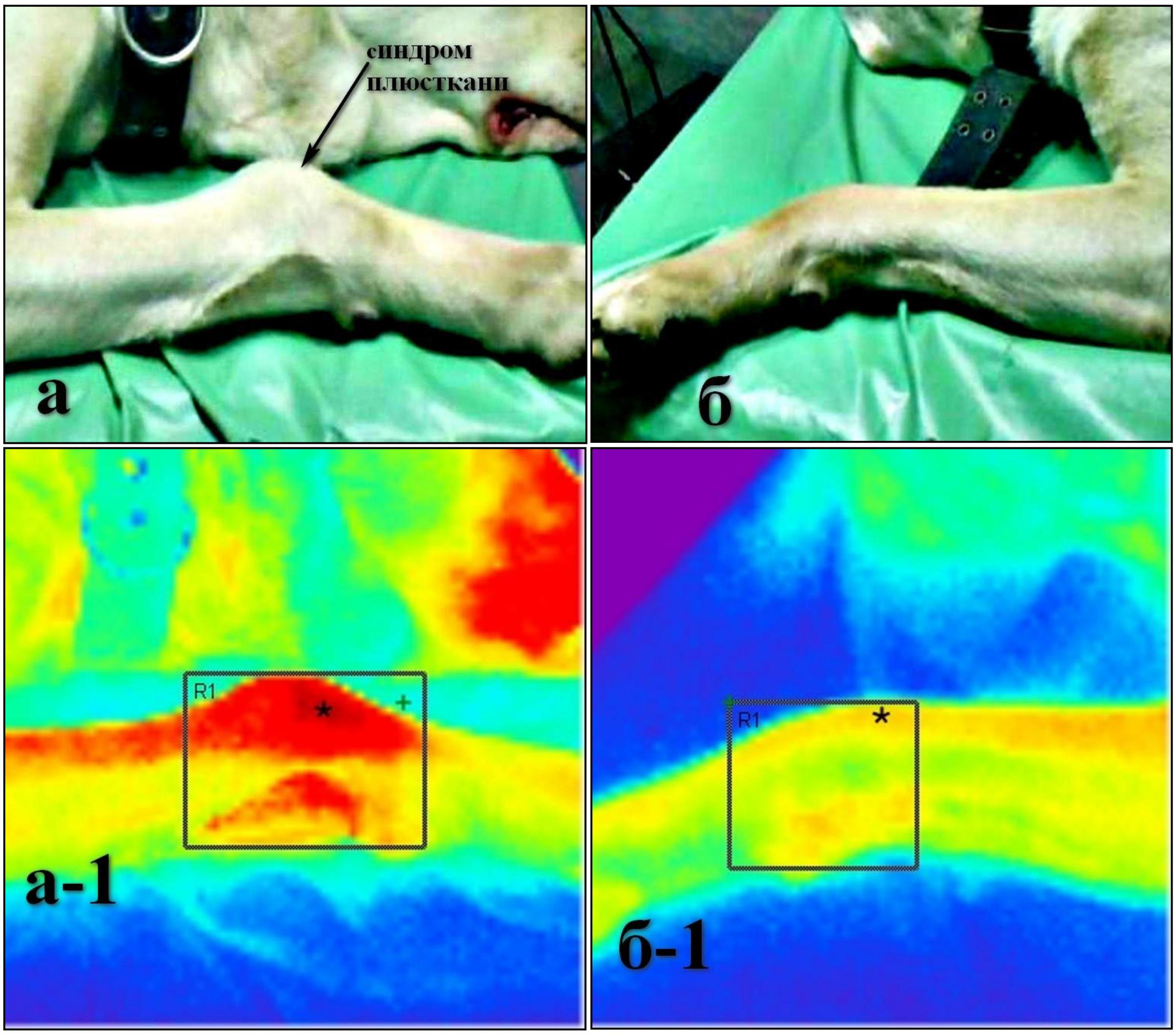


Figure 1: Average and thermographic visualization of the diseased limb with plus tissue syndrome (a; b) and of the symmetrical area of the healthy limb of the same animal (a-1; b-1). Markers P1, P2 and P3 indicate points of the temperature measuring (Table 1). See the explanations in the text.



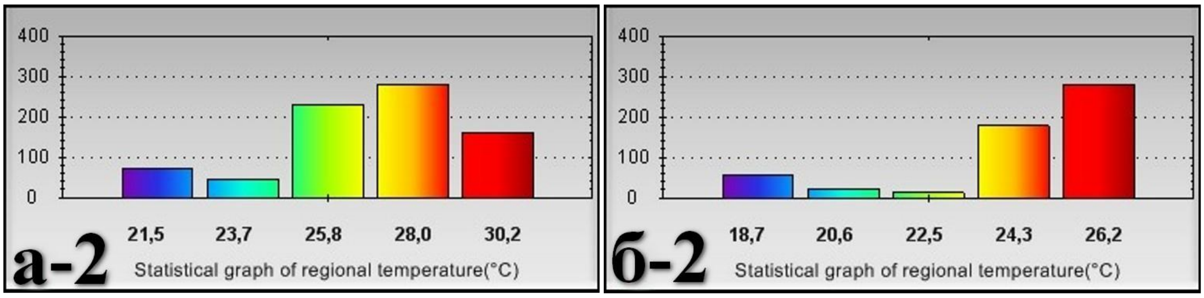


Figure 2: Comparative average and thermographic visualization of the diseased limb with the plus tissue syndrome induces by osteosarcoma (a) and of the symmetrical area of the healthy limb of the same animal (b). See the explanations in the text.

Studies have shown that a local increase in temperature in the area of the pathological focus (PF) can reach 5.6 °C (Table 1).

Table 1: Temperature characteristics of the pathological focus area in comparison with a healthy symmetric part of the body.

Limbs Healthy/diseased	Temperature by measuring points (°C) (Fig. 1 b; b-1)		
	P1	P2	P3
Diseased limb	31.5	30.3	31.5
Healthy limb	26.9	26.0	25.9
Δt (°C)	3.6	3.7	5.6

It was also noted that the reference temperature distribution over the entire area of the PF in all cases is shifted toward higher temperatures compared to the symmetric area of a healthy limb: from 21.5 °C to 30.2 °C and from 18.7 °C to 26.2 °C, respectively (Fig. 2a-2; Fig. 2b-2).

X-ray examination confirms the presence of the pathological process in this area, visualizing the varying degree of change in the X-ray density of both soft (Fig. 3a) and bone (Fig. 3b) tissues.

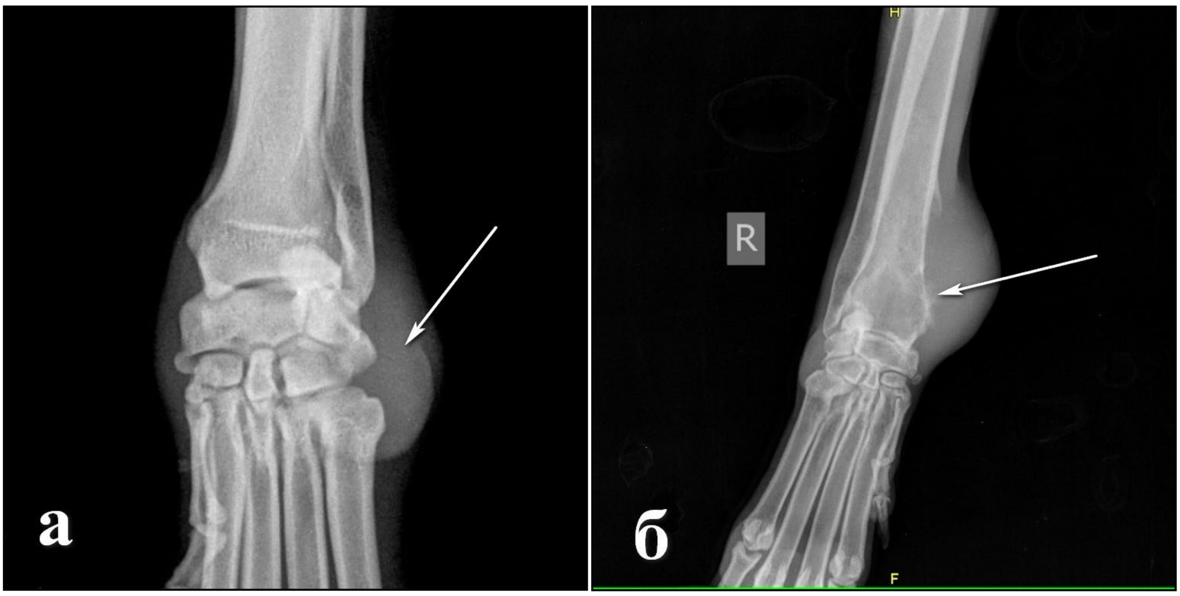


Figure 3: X-rays of those areas of limbs where the plus tissue syndrome and local temperature increase were visualized. a – see Fig. 1a, b. b – see Fig. 2a, a-1. See the explanations in the text.

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2 – The plus tissue syndrome without signs of the lameness.

TG examination of animals that lacked signs of lameness during a simple examination, but the PTS (Fig. 5a), in the area of localization of the latter, like in previous animals, an elevated temperature zone was visualized (Fig. 5b, c ; Fig. 4).

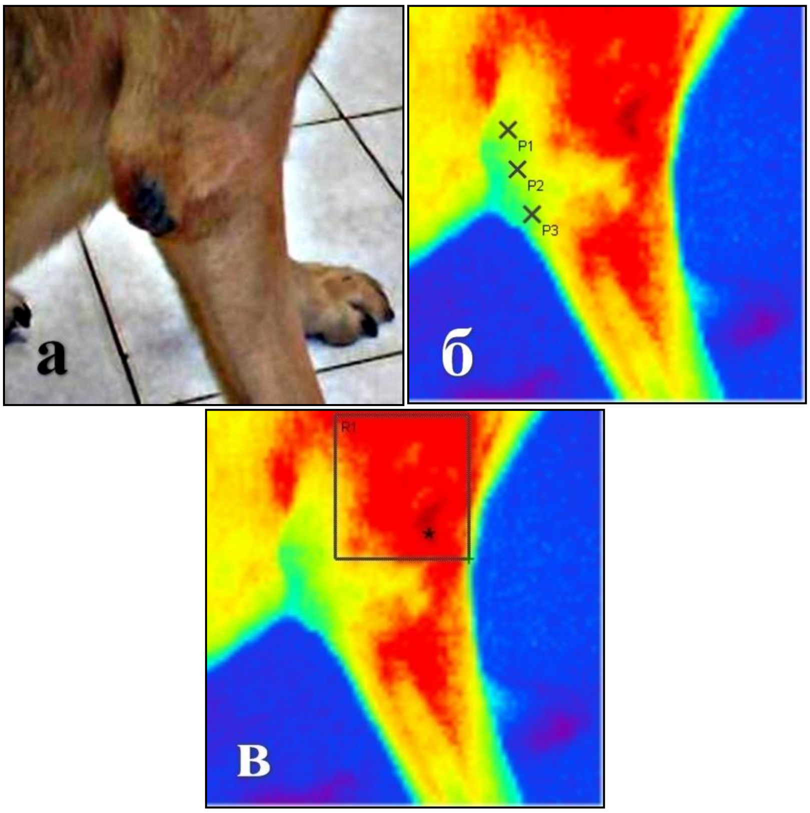
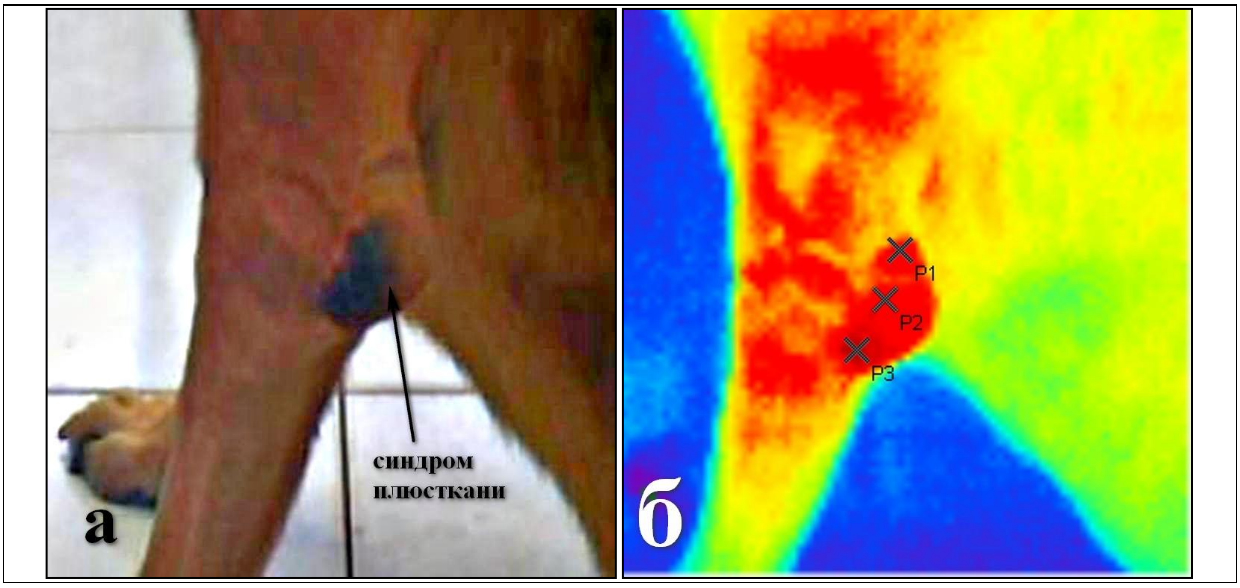


Figure 4: Photographic (a) and thermographic (b; c) images of the area of the elbow joint of the dog. See the explanations in the text.



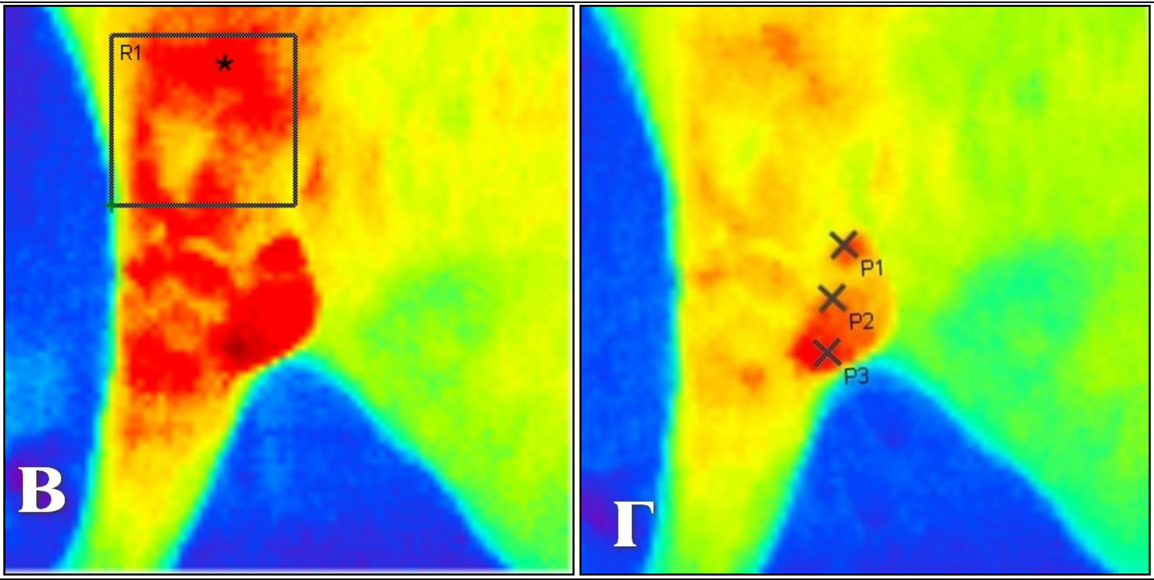


Figure 5:Photographic (a) and thermographic (a; b; c) images of the area of the elbow joint and the adjacent tissues of the dog with bursitis. See the explanations in the text.

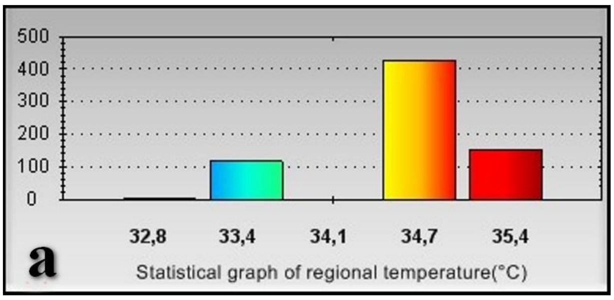
The local increase in temperature in the area of the PF compared with the symmetric point of a healthy limb was significant and reached 6.1 °C (Table 2).

Table 2: Temperature characteristics of the elbow tubercle bursitis in comparison with a healthy symmetric part of the body.

Limbs Healthy/diseased	Temperature by measuring points (°C) (Fig. 4; 5)		
	P1	P2	P3
Healthy limb (Fig. 4b)	31.7	31.4	31.1
Diseased limb (Fig. 5b)	36.4	35.8	37.2
Diseased limb after the beginning of treatment (Fig. 5d)	34.3	33.6	35.1

However, the reference temperature distribution in the area of the shoulder muscle projection was opposite (Fig. 4c; Fig. 5c).

From the side of a healthy limb, a temperature of 35.7 °C dominated (Fig. 6b).



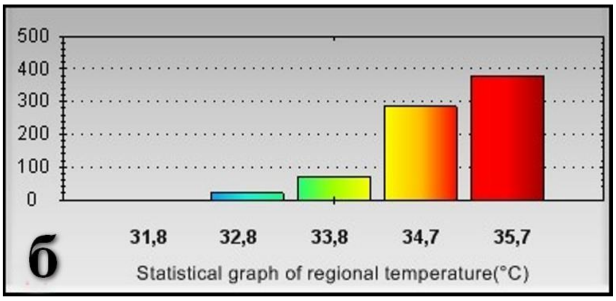


Figure 6: Graphic display of temperature characteristics of the projection area of the shoulder muscles on the limbs with bursitis of the olecranon (a) and the symmetric area of the projection of the shoulder muscles of a healthy limb (b). See the explanations in the text.

And in the area of diseased limb, the temperature of 34.7 °C dominated (Fig. 6a). The average temperature of the projection of the shoulder muscles area on the side of the extremity with elbow tubercle bursitis was 0.4 °C lower than the opposite one (Table 3).

Table 3: Temperature characteristics of the pathological focus area of carpus before and after the beginning of treatment.

Limbs Healthy/diseased	Temperature by measuring points (°C)		
	P1	P2	P3
Before the treatment (Fig. 1b)	31.5	30.3	31.5
After the treatment (Fig. 7b)	30.3	28.3	28.9
Δt (°C)	1.2	2.0	2.6

Repeated TG examinations after nonsteroidal anti-inflammatory drugs (NSAIDs) visualized a decrease in temperature at the site of the PF (Fig. 5b; Table 2; Fig. 7; Table 3).

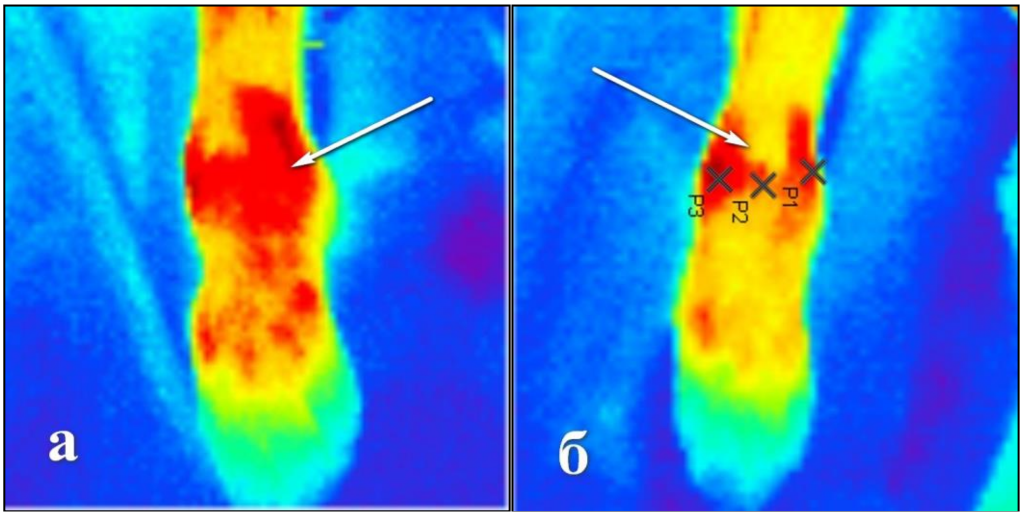


Figure 7: Thermographic visualization of the pathological focus area before (a) and after the beginning of treatment (b). See the explanations in the text.

3 – Support type lameness without the plus tissue syndrome.

TG examination of an animal that had a lameness of a support type, but showed no signs of the PTS, visualized that the temperature in the projection and thigh muscles was higher than in a similar symmetric area of a healthy limb (Fig. 8a, b).

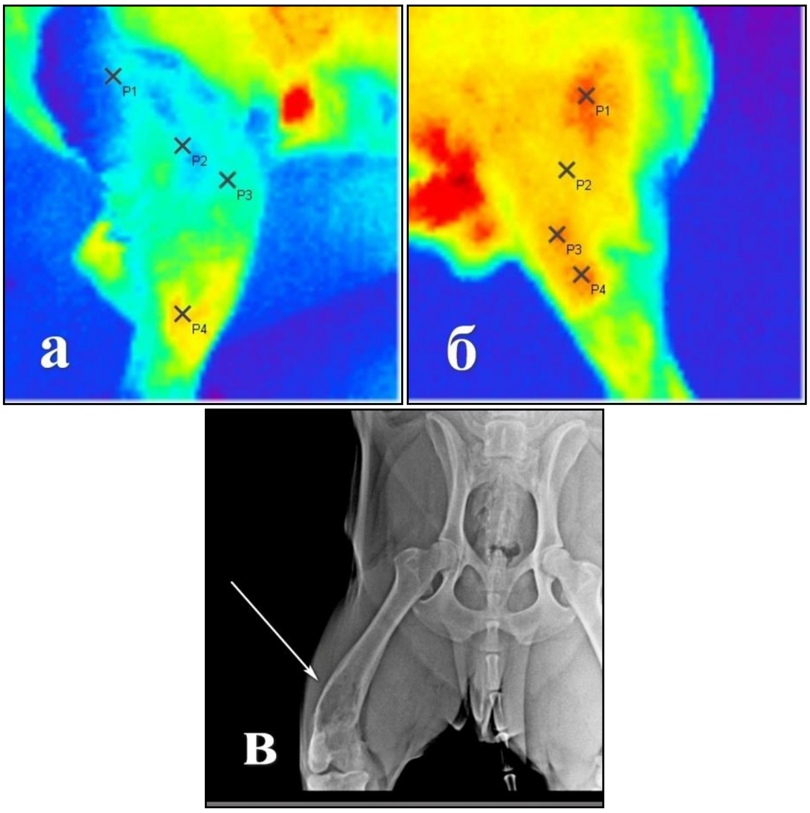


Figure 8:Temperature characteristics of the limb with a violation of the support function, but without the plus tissue syndrome in comparison with a healthy symmetric part of the body. a – healthy limb; b – diseased limb; c – X-ray of the diseased limb indicating the location of the pathological process (arrow). See the explanations in the text.

And at two points (points P1 and P3) the temperature difference was the highest (Table 4).

Table 4: Temperature characteristics of the limb with the support function violation, but without the plus tissue syndrome in comparison with a healthy symmetric part of the body.

Limbs Healthy/diseased	Temperature by measuring points (°C) (Fig. 8)			
	P1	P2	P3	P4
Healthy limb (Fig. 8a)	26.9	27.2	28.0	32.1
Diseased limb (Fig. 8b)	33.8	32.5	33.7	33.6
Δt (°C)	6.9	5.3	5.7	1.5

A subsequent X-ray examination revealed that higher temperature area correlates with intensive osteodestructionarea(Fig. 8c).

<u>**4 – Lameness of a hanging limb.**</u>

In animals with a lameness of a hanging limb, during the TG examination, signs of a diffuse drop in temperature throughout the limb with pathology are visualized (Fig. 9).

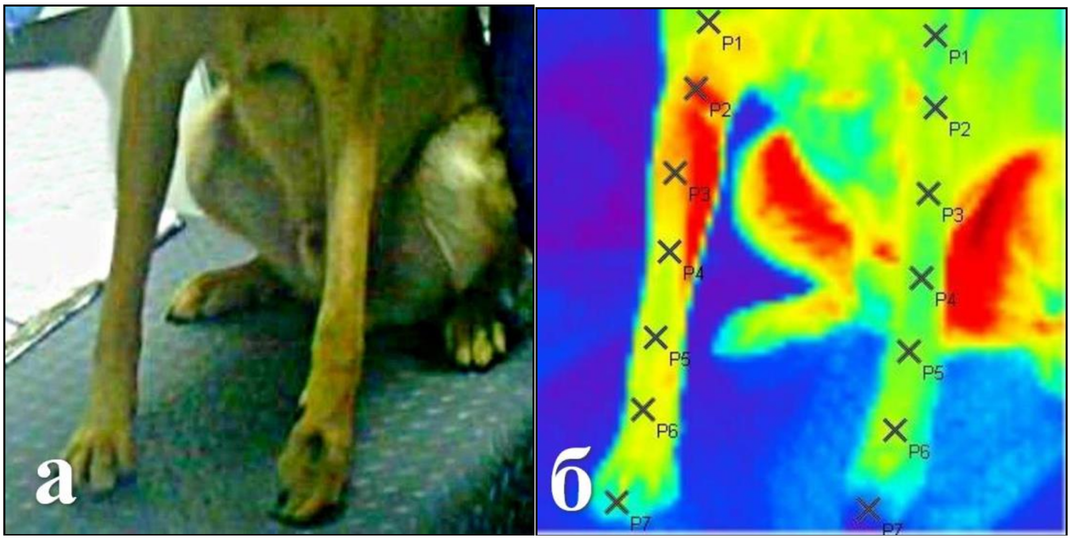


Figure 9: Photographic (a) and thermographic (b) images of the healthy (left) and diseased (right) limb of the dog. P1-P7 are the points of the precise temperature measurement represented in the Table 5. See the explanations in the text.

The temperature difference between the symmetrical points of the healthy and diseased limbs varies from 0.4 °C to 6.1 °C (Table 5).

Table 5: Comparative temperature of the healthy limb and the limb with the support function violation (Fig. 9b).

Limbs	Temperature by measuring points (°C)						
	P1	P2	P3	P4	P5	P6	P7
Healthy	31.2	34.1	32.5	30.6	29.4	29.7	28.0
Diseased	27.8	28.0	28.9	27.6	28.4	29.3	22.7
Δt (°C)	3.4	6.1	3.6	3.0	1.0	0.4	5.3

In the other clinical case, in addition to a general decrease in temperature over the entire surface of the diseased limb (Fig. 10; Table 6), a sharp temperature transition is visualized with the temperature difference of 8.2 °C (Fig. 10b (indicated by arrow)).

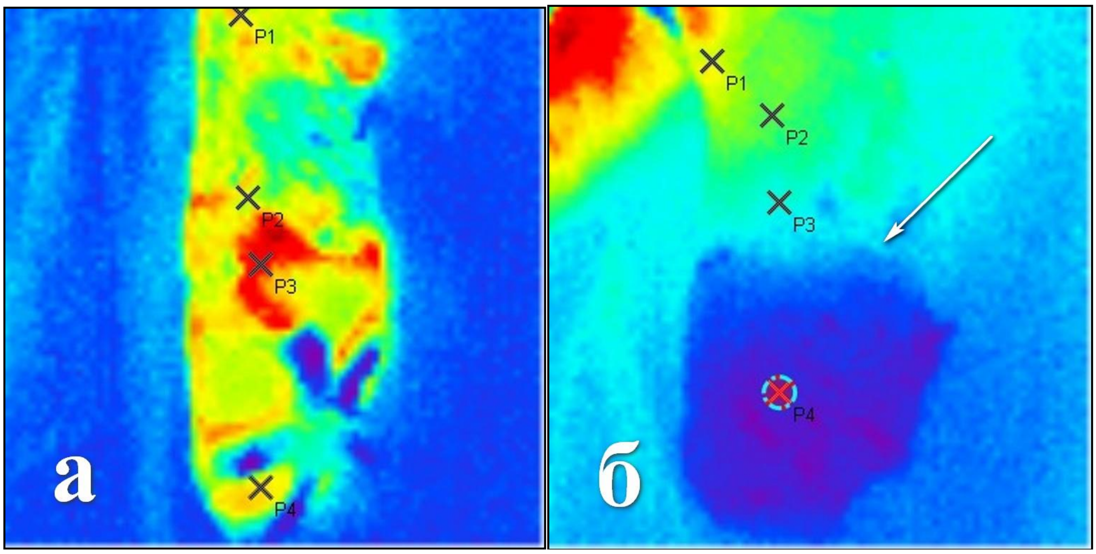


Figure 10:Thermographic image of the healthy (a) and diseased (b) limb of the dog. P1-P4 are the points of the precise temperature measurement represented in the Table 6. The arrow indicates the boundary of the sharp temperature change. See the explanations in the text.

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Table 6: Temperature characteristics of the distal part of the limb with the support function violation in comparison with a healthy symmetric part of the body.

Limbs Healthy/diseased	Temperature by measuring points (°C) (Fig. 10)			
	P1	P2	P3	P4
Healthy limb (Fig. 10a)	26.5	25.9	28.9	26.6
Diseased limb (Fig. 10b)	26.0	24.1	21.9	18.4
Δt (°C)	0.5	1.8	7.0	8.2

5 – Intermittent lameness (it appears then it disappears).

TG of the pelvic limbs of an animal that had a mild intermittent lameness showed that the projection area of the muscles of the thigh of the right limb is colored in a slightly less "warm" tone than the left one (Fig. 11a, b).

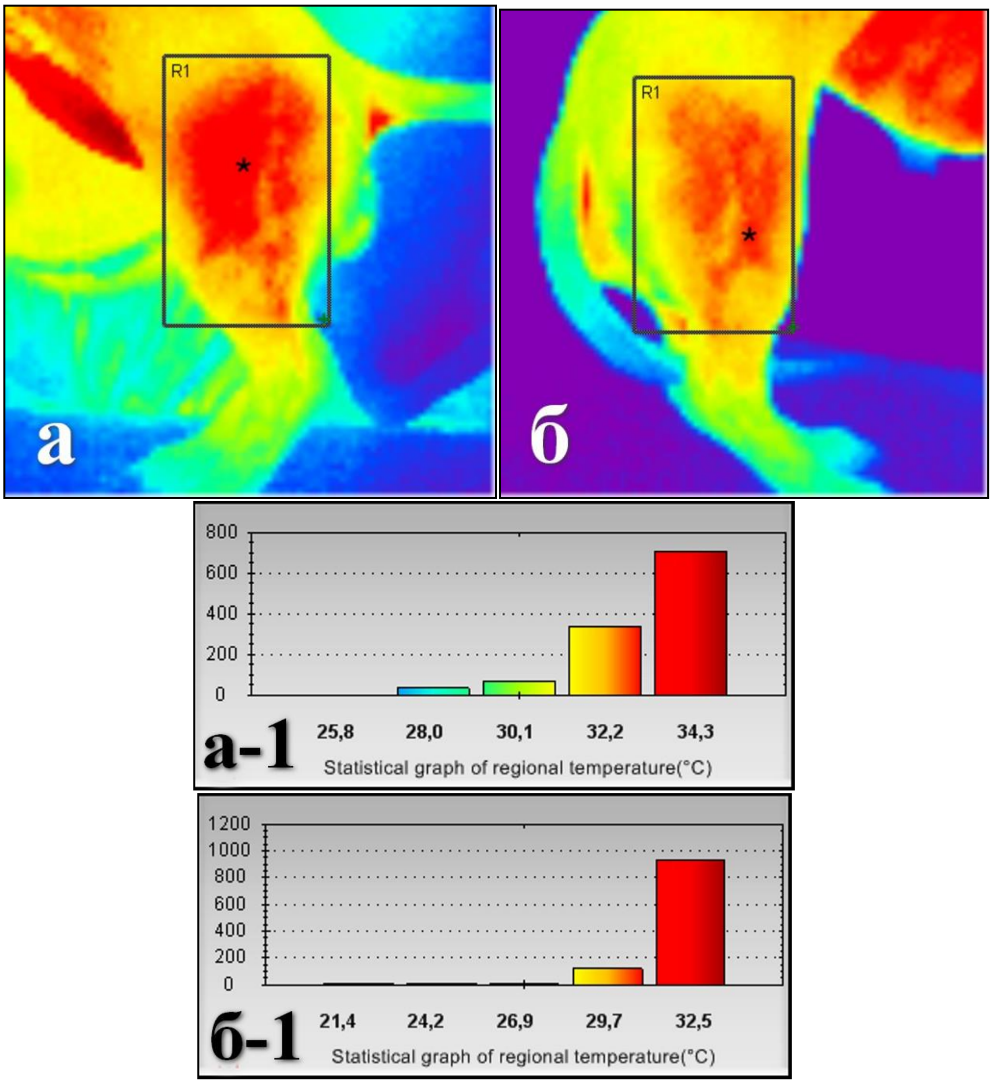

Figure 11:Thermograms of the left (a) and right (b) hind limbs of the dachshund dog with the insignificant intermittent lameness. See the explanations in the text.

Both maximum and average temperature in the measured area of the right limb was 1.3 °C and 0.5 °C lower than on the left onerespectively(Fig. 11a-1, b-1),(Table 7).

Table 7: Temperature characteristics of areas projections of the muscles of the left and right hips in dachshund dog with intermittent lameness.

Limbs	Temperature characteristics of areas indicated (°C) (Fig. 11 a-1; b-1)		
	Maximum	Average	Minimum
Left (Fig. 11a)	25.8	33.9	36.5
Right (Fig. 11b)	21.4	33.4	35.2
Δt (°C)	4.4	0.5	1.3

Subsequent X-ray diagnostics revealed a slight deformity of the hock joint of the right limb, caused by the curvature of the tibia, but without signs of arthrosis (Fig. 12).

Figure 12: X-ray of the hind limbs of the dachshund dog with the insignificant intermittent lameness. The arrow indicates the curvature of the tibia. See the explanations in the text.

DISCUSSION

Studies performed have shown that TG is able to quickly and remotely identify those areas in diseased limbs of animals which temperature differs from the temperature on symmetrical areas of a healthy limb (Fig. 1; Fig. 2; Table 1; Fig. 8; Table 4). The temperature in the localization of the PFcan be both higher than in the symmetrical part of the other limb, like in the case of inflammatory or neoplasm pathology (Fig. 4; Fig. 5; Table 2) and lower, like in the case of violation of nerve conduction and paresis or paralysis associated with this pathology(Fig. 9; Table 5) or when there is a blood supply disorder and signs of “thermoamputation”(Fig. 10; Table 6).The most interesting, in the context of this study, is the revealing of those clinical cases in which the presence of a pathological process visualized as a “hot zone” is not accompanied by visually observable signs of impaired support function of the limb (Fig. 4; Fig. 5). Nevertheless, even in these cases, TG allows visualizing and quantifying a decrease in the temperature of the body surface in the region of the projection of the muscles that play the main role in the movement of that limb (Fig. 6).Such a decrease in temperature indicates that the muscles of a diseased limb work less intensively. And this means that the violation of the support function still takes place, but in the preclinical stage.In some clinical cases, TG is able to identify the causes of intermittent lameness, not caused by a painful reaction, nerve conduction disturbance or hemodynamic disturbance (Fig. 11; Table 7). In the above study, a lower temperature was visualized and quantitatively evaluated in the area of the projection of the thigh muscles from the side of deformation of the hock due to the curvature of the tibia which still was not accompanied by clear signs of muscular atrophy(Fig. 12).In the course of this study, results were obtained on the possibility of monitoring the area of the PF in the treatment process(Fig. 7; Table 3). TG monitoring, in this case, allows obtaining of very accurate information about the trends of the pathological process. And unlike X-ray examination, such monitoring can be carried out infinitely often without risk of damage to the health of the patient.

The above information also suggests that TG of the muscular system of the extremities can be used as an indirect semi-quantitative method for estimation of the degree of lameness and as a method for monitoring it during treatment.

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