https://doi.org/10.17221/105/2025-VETMED

Efficacy of thermography for the early detection of dorsal metacarpal disease in young Thoroughbred horses

Karolina Sniegucka[1], Maria Soroko-Dubrovina[1], Paulina Zielinska[2], Krzysztof Dudek[3]*

[1]*Institute of Animal Breeding, Wroclaw University of Environmental and Life Sciences, Wroclaw, Poland*
[2]*Department of Surgery, Wroclaw University of Environmental and Life Sciences, Wroclaw, Poland*
[3]*Regional Center for Digital Medicine, 4th Military Clinical Hospital, Wroclaw, Poland*

**Corresponding author: karolina.sniegucka@upwr.edu.pl*

Citation: Sniegucka K, Soroko-Dubrovina M, Zielinska P, Dudek KD (2026): Efficacy of thermography for the early detection of dorsal metacarpal disease in young Thoroughbred horses. Vet Med-Czech 71, 441–450.

Abstract: Dorsal metacarpal disease (DMD) commonly affects young Thoroughbreds during early intensive training, making the early detection of subclinical inflammation essential. In this study, we examined 18 two-year-old Thoroughbreds with repeated thermographic, radiographic, and palpation assessments over six months, along with blood sampling to assess inflammatory markers. Seven horses developed DMD, whereas the remaining 11 served as controls. Thermography detected an increase in skin surface temperature over the third metacarpal bone before clinical signs appeared, which palpation confirmed about one week later. Radiographic abnormalities became evident only after thermographic changes and clinical signs had been detected. Blood inflammatory markers showed no significant correlation with imaging findings and demonstrated limited diagnostic value. Overall, thermography effectively detected DMD early.

Keywords: dorsal metacarpal disease; race training; skin surface temperature; thermography; third metacarpal bone; Thoroughbreds

Dorsal metacarpal disease (DMD) is a common fatigue-related injury in young performance horses that compromises the structural integrity of the distal limb skeleton (Firth et al. 2005). The condition has been reported to affect up to 70% of Thoroughbred racehorses during training (Nunamaker 2001). Kane et al. (2003) diagnosed DMD in 36 of 51 two-year-old Thoroughbreds, and the Japan Racing Association (1999) reported a 66% incidence during the first eight months of training. Periosteal lesions typically develop early in intensive training on the dorsal and dorsomedial aspects of the third metacarpal bone and are usually unilateral (Soroko et al. 2013), whereas bilateral lesions are uncommon (Palmer 2002). Clinical manifestations include lameness, local heat, swelling, and pain on palpation over the dorsal aspect of the third metacarpal bone (Nunamaker 2001).

Supported by Doctoral Grant obtained in 2022 (Agreement No. N020/0012/23).

© The authors. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0).

https://doi.org/10.17221/105/2025-VETMED

Traditional DMD diagnosis relies primarily on radiography and palpation (Nunamaker 2001). Palpation enables the detection of pain, swelling and periosteal remodelling, which can subsequently be confirmed radiographically (Soroko et al. 2013). However, radiographic evidence of dorsal cortical thickening becomes apparent only after bone mineral density has increased by at least 30% (Finsen and Anda 1988), potentially delaying the detection of early pathological changes (Couch and Nielsen 2017).

Monitoring inflammatory responses by using blood biomarkers, including white blood cell (WBC) count, serum amyloid A (SAA) concentration, and fibrinogen concentration, may facilitate the identification of early pathophysiological changes associated with DMD (Anhold et al. 2014). However, their value in detecting early musculoskeletal inflammation in young Thoroughbreds undergoing race training remains limited. Masko et al. (2021) demonstrated that WBC count and SAA concentrations increase after exercise, most likely reflecting physiological adaptation to training rather than localised musculoskeletal injury. Nevertheless, these systemic biomarkers may provide complementary information when interpreted alongside local imaging findings.

In this context, thermography has emerged as a valuable adjunctive diagnostic modality in veterinary medicine, providing non-invasive, contact-free assessment of skin surface temperature distribution (Soroko and Howell 2018). By recording the infrared radiation naturally emitted from the body surface, thermography provides real-time qualitative and quantitative information about tissue thermal patterns (Howell et al. 2020). Skin surface temperature reflects underlying physiological processes, including changes in peripheral blood flow, metabolic activity, vascularisation and inflammation. Consequently, thermography can identify subtle thermal asymmetries associated with early pathological changes before they become evident on radiographs or during clinical examination (Soroko et al. 2013).

Results from previous studies have shown that localised increases of 1 °C to 2 °C in skin surface temperature over the dorsal aspect of the third metacarpal bone may indicate subclinical DMD in young racehorses (Turner 1991; Soroko et al. 2013). Similarly, Michelotto et al. (2016) monitored DMD development in 12 Thoroughbred horses over four months and confirmed that thermography could detect subclinical inflammation of the third metacarpal bone before clinical abnormalities became apparent on palpation. However, no previous study has systematically compared thermographic findings with radiographic, palpation and haematological assessments in two-year-old Thoroughbreds throughout the first six months of race training. Therefore, the aim of the present study was to evaluate the efficacy of thermography, compared with radiography, palpation, and inflammatory blood markers, for early detection of DMD in two-year-old Thoroughbreds during the first year of race training.

MATERIAL AND METHODS

Before the study commenced, the Local Ethics Committee for Animal Experiments in Wroclaw, Poland (Approval No. 043/2023) approved the experimental protocol.

Animals and data collection

The study included 18 two-year-old Thoroughbred racehorses housed in individual stalls at the Partynice Racecourse in Wroclaw, Poland, during the 2023 racing season. The monitoring period extended from April to September. All horses had a comparable level of fitness and followed the same daily training programme, consisting of 1 000 m of trotting with the gradual introduction of speed training over distances ranging from 200 m to 500 metres. Horses were trained and raced clockwise, and none had a history of forelimb injury. Before enrolling horses, an experienced equine clinician performed a comprehensive musculoskeletal examination, including gait assessment, on all horses to confirm the absence of lameness or other clinically detectable musculoskeletal abnormalities. No horses received medication during the study.

We performed thermographic and radiographic examinations of both third metacarpal bones 10 times at 18-day intervals over six months. Palpation examinations were conducted once weekly. In addition, blood samples were collected every second imaging session (every 36 days) after completion of all other examinations. On each examination day, all horses remained at rest in their stalls before undergoing any diagnostic procedures or physical exercise.

https://doi.org/10.17221/105/2025-VETMED

Horses were withdrawn from the monitoring programme either after a confirmed diagnosis of DMD (DMD group) or after completing the six-month observation period without clinical or radiographic evidence of DMD (control group). Inclusion in the DMD group required radiographic confirmation.

Thermographic examination

Thermographic examinations were performed using a calibrated infrared camera (uncooled microbolometer focal plane array; detector resolution: 640 × 480 pixels; spectral range: 7.5–14 µm; noise-equivalent temperature difference <20 mK at 30 °C; equipped with a standard lens providing an instantaneous field of view of 0.57 mrad; measurement uncertainty: ±1% of the measured temperature range; VarioCam HR; InfraTec, Dresden, Germany).

A standardised thermographic protocol described in previous studies was followed (Soroko et al. 2013; Howell et al. 2020; Zielinska et al. 2021). Before each examination, horses were removed from their stalls and allowed to acclimatise to the stable environment for 20 minutes. All examinations were performed in an enclosed stable with the windows closed to minimise environmental influences, including air drafts and direct sunlight. Surface contaminants on the distal forelimbs, such as mud, were removed by brushing approximately 1 h before imaging. During image acquisition, an experienced assistant handled each horse and positioned it in the stable corridor.

Thermographic images of both forelimbs were acquired from the dorsal aspect (Figure 1) by the same operator (K.S.) throughout the study. All examinations were performed under comparable conditions and at the same time of day for each horse. Ambient temperature and relative humidity inside the stable were recorded at each session by using a thermometer (TES-1314; TES, Taipei, Taiwan).

A single investigator (K.S.) performed thermographic image analysis by using software (IRBIS 3 Professional; InfraTec, Dresden, Germany). For each examination, six regions of interest (ROIs) were analysed. Within each ROI, the mean, standard deviation (SD), minimum (Min) and maximum (Max) temperatures were recorded. Vertical reference lines were used to ensure consistent ROI placement between examinations.

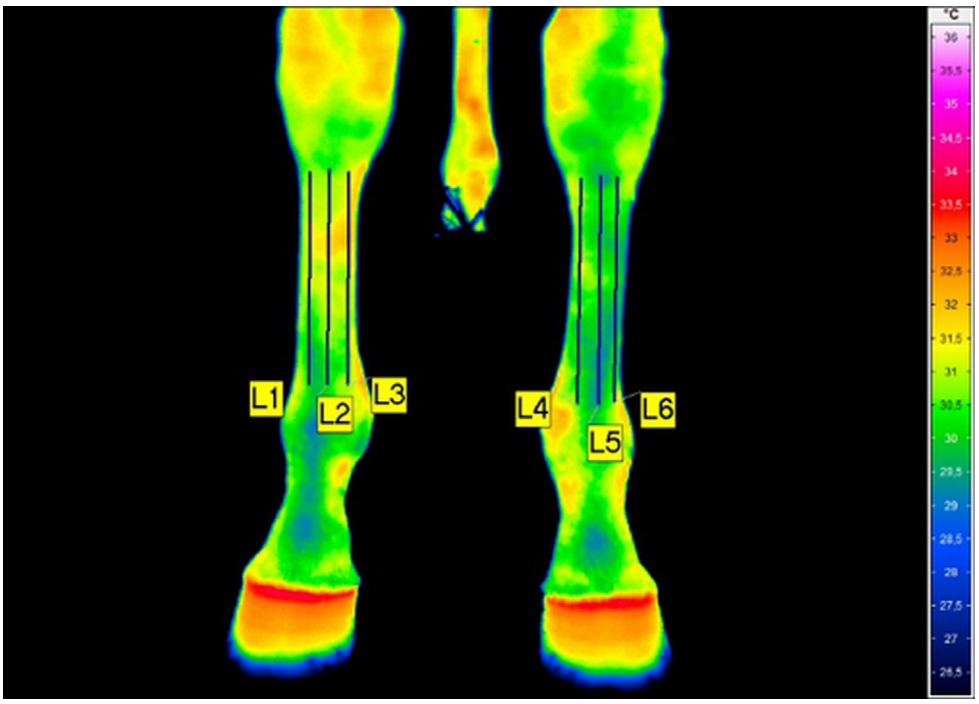


Figure 1. Example of a thermographic image of distal forelimbs from the dorsal aspect
Symmetric areas were examined and included both forelimbs from the dorsal aspect: L1 = lateral bone area of the right third metacarpal bone, L2 = central bone area of the right third metacarpal bone, L3 = medial bone area of the right third metacarpal bone, L4 = medial bone area of the left third metacarpal bone, L5 = central bone area of the left third metacarpal bone and L6 = lateral bone area of the left third metacarpal bone

https://doi.org/10.17221/105/2025-VETMED

Radiographic examination

Radiographic examinations were performed using a digital radiography system consisting of an X-ray generator (meX+20BT lite; medical ECONET, Oberhausen, Germany) and a digital radiography detector (PRIMOS 1210T MOD; Vieworks, Gwanyang-dong, Anyang-si, Gyeonggi-do, Republic of Korea).

Immediately after the thermographic examination, radiographs of both third metacarpal bones were obtained in the lateromedial projection by a single examiner (K.S.) using an exposure setting of 66 kVp and 1.8 mAs. The imaging field encompassed the entire length of the third metacarpal bone. The dorsal cortex of each third metacarpal bone was evaluated and measured by the same veterinarian (K.S.) using software VXvue (Vieworks, Gwanyang-dong, Anyang-si, Gyeonggi-do, Republic of Korea), as previously described by Slowinski et al. (2024).

Palpation examination

The same veterinarian palpated the third metacarpal bone once weekly before the daily training session. The examination was conducted to assess pain, swelling, and increased local heat over the dorsal aspect of the third metacarpal bone. The examiner subjectively assessed skin surface temperature using the palmar surface of the examiner's hand to compare both forelimbs, and evaluated pain by digital palpation. The examiner palpated both forelimbs from proximal to distal while weight-bearing and from distal to proximal with the limb flexed and lifted, following the procedure described by Baxter (2011). A positive palpation result was defined as the presence of a pain response ((withdrawal of the limb and/or movement of the horse away from the applied pressure) elicited by palpation over the dorsal aspect of the third metacarpal bone. Limbs that did not exhibit a pain response were classified as non-painful.

Blood sample collection

During blood collection, each horse was restrained by an experienced handler (M.S.D.) in its stall. Before venipuncture, the skin over the injection site was disinfected with sterile gauze soaked in 70% isopropyl alcohol. Blood samples were collected using a sterile system (BD Vacutainer®; Becton, Dickinson and Company, Franklin Lakes, NJ, USA) with a 20-G needle, 38 mm in length. All samples were collected by the same operator (K.S.). No pharmacological restraint or sedation was used. Venous blood was obtained via puncture of the left external jugular vein.

Blood samples were collected into three types of collection tubes: K_2-ethylenediaminetetraacetic acid tubes for WBC count analysis, clot activator tubes for SAA concentration determination and 3.2% sodium citrate tubes for fibrinogen concentration measurement.

Immediately after collection, samples were stored in a portable transport cooler at approximately 4 °C and transported to the Polish Veterinary Laboratory (VetLab, Wroclaw, Poland), where they were analysed within 1 h of collection. Haematological analyses were performed using a haematology analyser (Sysmex XN-1000; Sysmex America Inc., Lincolnshire, IL, USA), and WBC counts were reported as $\times 10^9$/l. The reference interval for WBC count was 5.6×10^9/l to 12.1×10^9/l. SAA concentrations were determined by means of an immunoturbidimetric assay using an analyser (AU680/AU5800; Beckman Coulter, Brea, CA, USA). SAA concentrations ≤2.0 mg/l were considered within the reference range. Plasma fibrinogen concentration was determined using the Clauss coagulation method with an analyser (Bio-Ksel Sp. z o.o., Grudziądz, Poland). The reference interval for fibrinogen concentration was 1.50 g/l to 3.30 g/l.

Statistical analysis

Statistical analyses were performed using STATISTICA v13.3 (TIBCO Software Inc., Palo Alto, CA, USA). To reduce the influence of ambient temperature, we used the temperature span (Span), defined as the difference between the maximum and minimum skin surface temperatures within each ROI. Differences in Span values between horses were evaluated using a *t*-test for independent samples, whereas temperatures of the left and right third metacarpal bones were compared using a paired *t*-test. Spearman's rank correlation coefficient was used to assess the strength and significance of the relationships between ROI temperature, dorsal cortical thickness and blood

https://doi.org/10.17221/105/2025-VETMED

parameters. For variables requiring repeated measurements, we obtained three measurements and used the mean for statistical analysis. Cortical thickness measurements were rounded to the nearest 0.1 mm.

RESULTS

The DMD group comprised seven horses with unilateral lesions, including three affecting the right forelimb and four affecting the left forelimb. The control group consisted of 11 horses that remained free of clinical and radiographic evidence of DMD throughout the study.

Thermographic examination

Thermographic assessment revealed significant differences in skin surface temperature over the third metacarpal bone between the DMD and control groups on days 54, 72 and 90 of the monitoring period. Specifically, horses that subsequently developed DMD showed significantly higher temperatures ($P < 0.05$) at line L1 during the fourth examination session and at line L4 during the fifth and sixth sessions than the control group (Table 1).

Weekly palpation examinations performed after each thermographic assessment confirmed the onset of clinical signs of DMD in horses that had previously exhibited increased skin surface temper-

Table 1. Basic statistics of the difference in temperature (Span – range = Max – Min) of the group with DMD and the control group without DMD across 10 sessions and the results of significance tests (*t*-test for independent samples)

Session (time)	Body surface temperature indicator	Group of horses ($N = 18$)		With vs without DMD
		group with DMD ($n = 7$)	control group without DMD ($n = 11$)	
1 (1st day)	L1Span (°C), mean ± SD	1.48 ± 0.59	1.70 ± 0.64	$P = 0.468$
	L2Span (°C), mean ± SD	1.14 ± 0.28	1.42 ± 0.63	$P = 0.284$
	L3Span (°C), mean ± SD	1.30 ± 0.39	1.39 ± 0.53	$P = 0.712$
	L4Span (°C), mean ± SD	1.16 ± 0.46	1.73 ± 1.87	$P = 0.444$
	L5Span (°C), mean ± SD	1.03 ± 0.30	1.86 ± 1.87	$P = 0.265$
	L6Span (°C), mean ± SD	1.21 ± 0.53	2.21 ± 1.56	$P = 0.124$
2 (19th day)	L1Span (°C), mean ± SD	1.50 ± 0.39	1.75 ± 0.71	$P = 0.410$
	L2Span (°C), mean ± SD	1.39 ± 0.60	1.50 ± 0.56	$P = 0.704$
	L3Span (°C), mean ± SD	1.40 ± 0.66	1.16 ± 0.44	$P = 0.376$
	L4Span (°C), mean ± SD	1.25 ± 0.24	1.40 ± 0.57	$P = 0.539$
	L5Span (°C), mean ± SD	1.14 ± 0.25	1.20 ± 0.29	$P = 0.674$
	L6Span (°C), mean ± SD	1.44 ± 0.54	1.52 ± 0.43	$P = 0.745$
3 (36th day)	L1Span (°C), mean ± SD	1.18 ± 0.41	1.41 ± 0.41	$P = 0.273$
	L2Span (°C), mean ± SD	1.00 ± 0.23	0.94 ± 0.35	$P = 0.698$
	L3Span (°C), mean ± SD	0.93 ± 0.20	0.94 ± 0.33	$P = 0.949$
	L4Span (°C), mean ± SD	1.27 ± 0.51	1.02 ± 0.34	$P = 0.236$
	L5Span (°C), mean ± SD	1.04 ± 0.39	1.19 ± 0.36	$P = 0.437$
	L6Span (°C), mean ± SD	0.34 ± 0.16	0.38 ± 0.14	$P = 0.649$
4 (53rd day)	L1Span (°C), mean ± SD	1.34 ± 0.22	1.05 ± 0.31	$P = 0.046$
	L2Span (°C), mean ± SD	1.37 ± 0.28	1.06 ± 0.38	$P = 0.079$
	L3Span (°C), mean ± SD	1.44 ± 0.59	1.10 ± 0.44	$P = 0.181$
	L4Span (°C), mean ± SD	1.17 ± 0.57	1.38 ± 0.47	$P = 0.393$
	L5Span (°C), mean ± SD	1.37 ± 0.71	1.42 ± 0.45	$P = 0.873$
	L6Span (°C), mean ± SD	1.32 ± 0.56	1.34 ± 0.40	$P = 0.927$

https://doi.org/10.17221/105/2025-VETMED

Table 1 to be continued

Session (time)	Body surface temperature indicator	Group of horses (N = 18)		With vs without DMD
		group with DMD (n = 7)	control group without DMD (n = 11)	
5 (72nd day)	L1Span (°C), mean ± SD	0.93 ± 0.70	0.84 ± 0.26	P = 0.687
	L2Span (°C), mean ± SD	0.75 ± 0.46	0.83 ± 0.33	P = 0.660
	L3Span (°C), mean ± SD	0.85 ± 0.61	0.75 ± 0.19	P = 0.612
	L4Span (°C), mean ± SD	0.73 ± 0.25	0.74 ± 0.26	P = 0.910
	L5Span (°C), mean ± SD	0.85 ± 0.35	0.67 ± 0.20	P = 0.044
	L6Span (°C), mean ± SD	0.77 ± 0.27	0.91 ± 0.29	P = 0.334
6 (90th day)	L1Span (°C), mean ± SD	1.50 ± 1.02	1.17 ± 0.28	P = 0.311
	L2Span (°C), mean ± SD	1.24 ± 0.98	1.04 ± 0.17	P = 0.516
	L3Span (°C), mean ± SD	1.44 ± 0.67	1.01 ± 0.28	P = 0.074
	L4Span (°C), mean ± SD	1.65 ± 0.85	0.79 ± 0.34	P = 0.036
	L5Span (°C), mean ± SD	1.34 ± 0.66	1.00 ± 0.37	P = 0.173
	L6Span (°C), mean ± SD	1.35 ± 0.50	1.20 ± 0.25	P = 0.405
7 (108th day)	L1Span (°C), mean ± SD	0.94 ± 0.19	1.45 ± 1.62	P = 0.423
	L2Span (°C), mean ± SD	1.14 ± 0.43	1.59 ± 2.40	P = 0.634
	L3Span (°C), mean ± SD	1.28 ± 0.71	1.54 ± 2.45	P = 0.787
	L4Span (°C), mean ± SD	0.86 ± 0.26	1.27 ± 0.95	P = 0.281
	L5Span (°C), mean ± SD	1.02 ± 0.41	1.04 ± 0.62	P = 0.960
	L6Span (°C), mean ± SD	1.06 ± 0.43	1.16 ± 0.49	P = 0.653
8 (126th day)	L1Span (°C), mean ± SD	1.27 ± 0.31	1.30 ± 0.46	P = 0.911
	L2Span (°C), mean ± SD	1.12 ± 0.45	1.06 ± 0.49	P = 0.823
	L3Span (°C), mean ± SD	1.12 ± 0.30	0.99 ± 0.25	P = 0.331
	L4Span (°C), mean ± SD	1.60 ± 1.00	1.09 ± 0.55	P = 0.179
	L5Span (°C), mean ± SD	1.33 ± 0.89	1.13 ± 0.48	P = 0.532
	L6Span (°C), mean ± SD	1.46 ± 0.76	1.20 ± 0.34	P = 0.349
9 (144th day)	L1Span (°C), mean ± SD	0.92 ± 0.34	1.04 ± 0.26	P = 0.410
	L2Span (°C), mean ± SD	1.25 ± 0.86	0.96 ± 0.43	P = 0.360
	L3Span (°C), mean ± SD	1.35 ± 0.57	0.89 ± 0.46	P = 0.075
	L4Span (°C), mean ± SD	1.06 ± 0.59	0.95 ± 0.32	P = 0.590
	L5Span (°C), mean ± SD	0.91 ± 0.36	1.05 ± 0.36	P = 0.444
	L6Span (°C), mean ± SD	1.07 ± 0.35	1.08 ± 0.38	P = 0.940
10 (162nd day)	L1Span (°C), mean ± SD	1.32 ± 0.50	1.24 ± 0.34	P = 0.704
	L2Span (°C), mean ± SD	1.03 ± 0.39	1.31 ± 0.48	P = 0.200
	L3Span (°C), mean ± SD	1.37 ± 0.67	1.34 ± 0.43	P = 0.929
	L4Span (°C), mean ± SD	1.42 ± 0.61	1.21 ± 0.33	P = 0.348
	L5Span (°C), mean ± SD	1.06 ± 0.52	1.24 ± 0.38	P = 0.420
	L6Span (°C), mean ± SD	1.11 ± 0.42	1.36 ± 0.31	P = 0.175

Statistically significant values (P < 0.05) are highlighted in red font

DMD = dorsal metacarpal disease; L1 = lateral bone area of the right third metacarpal bone; L2 = central bone area of the right third metacarpal bone; L3 = medial bone area of the right third metacarpal bone; L4 = medial bone area of the left third metacarpal bone; L5 = central bone area of the left third metacarpal bone; L6 = lateral bone area of the left third metacarpal bone; Max = maximum temperature; Min = minimum temperature; SD = standard deviation; *Span* = temperature range (Max – Min)

https://doi.org/10.17221/105/2025-VETMED

ature over the dorsal aspect of the third metacarpal bone. After the fourth thermographic session, three horses developed clinical signs in the right forelimb. After the fifth session, two additional horses developed clinical signs in the left forelimb, and after the sixth session, DMD was diagnosed in two further horses, also affecting the left forelimb. In all affected horses, clinical examination revealed pain, increased local heat and swelling over the dorsal aspect of the third metacarpal bone.

Radiographic examination

Significant differences in dorsal cortical thickness of the third metacarpal bone were observed between the DMD and control groups on days 90 and 162 of the monitoring period.

We found a negative correlation between skin surface temperature and dorsal cortical thickness in the DMD group; however, this relationship was not statistically significant ($P > 0.05$). Likewise, no significant correlations were observed between WBC count, SAA concentration, fibrinogen concentration and either skin surface temperature or dorsal cortical thickness in either group.

Blood sample analysis

No significant differences in WBC count were observed between the DMD and control groups at any sampling point ($P > 0.05$). Only one horse in the control group had an increased SAA concentration during the first sampling session, whereas SAA concentrations remained within the reference range in all other horses throughout the study.

Fibrinogen concentrations in the DMD group generally decreased across successive sampling sessions, except during the seventh session, when they reached their highest level. The control group showed a similar peak during the seventh session. Between the third and fifth sampling sessions, fibrinogen concentrations decreased in the DMD group but increased in the control group.

DISCUSSION

In the present study, DMD was diagnosed in 39% of the examined horses, with subclinical inflammation first detected by thermography and later confirmed by palpation and radiography. Bailey et al. (1999) reported comparable findings, observing bucked shins in 42% of two-year-old Thoroughbred racehorses. DMD develops when insufficient bone adaptation to high-speed exercise results in repetitive microdamage and subsequent periosteal new bone formation on the dorsal cortex of the third metacarpal bone. These findings highlight the importance of structured veterinary monitoring protocols to prevent DMD from progressing to clinically apparent disease.

The present findings demonstrate that thermography can be used to detect localised increases in skin surface temperature before the onset of clinical signs of DMD, supporting its value as an early diagnostic modality. Temperature elevations were observed on days 54, 72, and 90 of training, whereas clinical signs, including pain, swelling, and increased local heat, became evident about one week later. Radiographic evidence of periosteal remodelling was observed only from the sixth imaging session onward, indicating that thermographic abnormalities preceded both clinical manifestations and radiographic confirmation of the disease. These observations are consistent with those of previous studies in which the investigators reported that thermography can be used to identify subclinical inflammation before overt clinical signs appear. Turner (1991) described thermographically detectable inflammatory changes approximately two weeks before clinical recognition, whereas Soroko et al. (2013) reported early thermographic alterations in 14 of 20 racehorses evaluated using combined diagnostic methods. Similarly, Prochno et al. (2020) demonstrated the usefulness of thermography for identifying early training-related changes in young Thoroughbred racehorses, emphasising its potential for detecting subclinical inflammation associated with DMD. Collectively, these findings suggest that thermography may enable earlier identification of DMD-associated inflammatory processes than can conventional clinical or radiographic assessment, thereby allowing earlier intervention and potentially limiting the progression of periosteal damage in young Thoroughbreds.

Our findings are further supported by Michelotto et al. (2016), who showed that thermography detected DMD-related abnormalities before clinical signs became evident. Unlike that study, how-

https://doi.org/10.17221/105/2025-VETMED

ever, we compared thermographic findings not only with palpation but also with radiographic examination and inflammatory blood marker levels, providing a more comprehensive evaluation of thermography's diagnostic performance. The results of this multimodal approach further support thermography as a sensitive tool for early detection of DMD.

Although we observed a negative correlation between skin surface temperature and dorsal cortical thickness in horses with DMD, the relationship was not statistically significant. This pattern likely reflects the different biological processes assessed by means of thermography and radiography. Thermography helps detect early physiological responses associated with increased tissue perfusion and inflammation, whereas radiography primarily helps identify structural bone remodelling that develops at later stages of the disease. Similar observations have been reported previously, suggesting that thermal abnormalities may precede radiographic changes (Soroko et al. 2012). Consequently, combining thermographic and radiographic examinations may improve DMD diagnosis by providing complementary information about different stages of disease progression (Okur et al. 2023).

The observed negative relationship between thermographic and radiographic findings may also reflect the reduced sensitivity of thermography for chronic musculoskeletal lesions compared with radiography (Zaha et al. 2023). As inflammation becomes chronic, skin surface temperature may gradually normalise, whereas radiographic abnormalities, including dorsal cortical thickening, become detectable only after substantial bone remodelling has occurred. Finsen and Anda (1988) reported that radiographic thickening of the dorsal cortex of the third metacarpal bone became evident only after bone mineral density had increased by at least 30%. Despite its limited ability to detect early pathological changes, radiography remains the reference imaging modality for confirming DMD. In contrast, subtle increases in skin surface temperature may not be recognised during routine clinical observation by trainers or owners. Consequently, radiographic examination performed after the onset of clinical signs frequently confirms already established periosteal remodelling. These findings emphasise the complementary roles of thermography and radiography in improving the early diagnosis of DMD.

No significant correlations were identified between systemic inflammatory markers (WBC count, SAA concentration and fibrinogen concentration), skin surface temperature over the third metacarpal bone and dorsal cortical thickness, indicating the limited diagnostic value of these biomarkers for DMD. Although Anhold et al. (2014) reported variation in WBC count, SAA concentration, and fibrinogen concentration in relation to the general health status of Thoroughbred horses, the investigators did not specifically investigate DMD and therefore did not provide direct evidence supporting their use in diagnosing this condition. The absence of significant correlations in the present study supports the hypothesis that DMD is a localised bone disorder that does not induce a measurable systemic inflammatory response, particularly during its early stages. This interpretation is consistent with the radiographic confirmation of periosteal remodelling and the thermographic detection of localised increases in skin surface temperature before structural changes became radiographically apparent. Consequently, whereas thermography and radiography reflect local pathophysiological processes associated with DMD, systemic inflammatory markers such as WBC count, SAA concentration and fibrinogen concentration appear to have limited sensitivity and specificity for the early detection of this condition.

The present study has several limitations. First, the relatively small number of horses with DMD diagnosed may have reduced the statistical power of the analyses. Second, more frequent examinations than the 18-day interval used in the present study might have provided a more detailed characterisation of the temporal progression of thermographic and radiographic changes. Furthermore, we did not observe bilateral DMD; therefore, we could not evaluate the diagnostic performance of thermography in horses with bilateral disease. Future studies may also benefit from using relative temperature measurements referenced to a clinically unaffected region of the same forelimb, which could improve diagnostic accuracy.

These findings indicate that thermography is a promising tool for early detection of subclinical inflammation and bone stress associated with DMD. Thermography may help identify pathological changes before clinical or radiographic abnormalities become evident and, when used alongside palpation and radiography, could enhance monitoring

https://doi.org/10.17221/105/2025-VETMED

protocols aimed at reducing injury risk and improving the welfare of young Thoroughbred racehorses.

This study shows that thermography is a sensitive, non-invasive imaging modality for early detection of subclinical inflammation associated with DMD in young Thoroughbreds. Thermographic examination helped to identify localised increases in skin surface temperature before clinical abnormalities became evident on palpation or radiographic examination, highlighting thermography's potential value for early diagnosis. However, we could not assess the diagnostic performance of thermography in horses with bilateral DMD because the present study identified no bilateral cases. Further investigations in larger populations and with more frequent examination intervals are warranted to validate these findings and establish clinically applicable diagnostic thresholds.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

Anhold H, Candon R, Chan DS, Amos W. A comparison of elevated blood parameter values in a population of Thoroughbred racehorses. J Equine Vet Sci. 2014 May; 34(5):651-5.

Bailey CJ, Reid SW, Hodgson DR, Rose RJ. Impact of injuries and disease on a cohort of two- and three-year-old Thoroughbreds in training. Vet Rec. 1999 Oct 23;145(17): 487-93.

Baxter GM, editor. Adams and Stashak's lameness in horses. 6th ed. Hoboken (NJ): Wiley-Blackwell; 2011. p. 93.

Couch S, Nielsen BD. A review of dorsal metacarpal disease (bucked shins) in the flat racing horse: Prevalence, diagnosis, pathogenesis, and associated factors. J Dairy Vet Anim Res. 2017 Sep;5(6):228-36.

Finsen V, Anda S. Accuracy of visually estimated bone mineralization in routine radiographs of the lower extremity. Skeletal Radiol. 1988 Jun;17(4):270-5.

Firth EC, Rogers CW, Doube M, Jopson NB. Musculoskeletal responses of 2-year-old Thoroughbred horses to early training. 6. Bone parameters in the third metacarpal and third metatarsal bones. N Z Vet J. 2005 Apr;53(2):101-12.

Howell KJ, Dudek K, Soroko M. Thermal camera performance and image analysis repeatability in equine thermography. Infrared Phys Technol. 2020;110:103447.

Japan Racing Association. Annual report on racehorse hygiene: Number of new patients. Tokyo: Japan Racing Association; 1999. p. 24-44.

Kane AJ, McIlwraith CW, Park RD, Rantanen NW, Morehead JP, Bramlage LR. Radiographic changes in Thoroughbred yearlings. Part 2: Associations with racing performance. Equine Vet J. 2003 Jun;35(4):366-74.

Masko M, Domino M, Jasinski T, Witkowska-Pilaszewicz O. The physical activity-dependent hematological and biochemical changes in school horses in comparison to blood profiles in endurance and race horses. Animals (Basel). 2021 Apr;11(4):1128.

Michelotto BL, Rocha RMVM, Michelotto PV Jr. Thermographic detection of dorsal metacarpal/metatarsal disease in 2-year-old Thoroughbred racehorses: A preliminary study. J Equine Vet Sci. 2016 Sep;44:37-41.

Nunamaker DM. Bucked shins in horses. In: Burr DB, Milgrom C, editors. Musculoskeletal fatigue and stress fractures. Boca Raton (FL): CRC Press; 2001. p. 203-19.

Okur S, Yanmaz LE, Golgeli Bedir A, Senocak MG, Ersoz U, Orhun OT, Kocaman Y. The effectiveness of thermography in determining localization of orthopedic diseases in horses. Van Vet J. 2023;34(1):51-4.

Palmer SE. Treatment of dorsal metacarpal disease in the Thoroughbred racehorse with radial extracorporeal shock wave therapy. Proc Am Assoc Equine Pract. 2002;48: 318-21.

Prochno HC, Barussi FM, Bastos FZ, Weber SH, Bechara GH, Rehan IF, Michelotto PV Jr. Infrared thermography applied to monitoring musculoskeletal adaptation to training in Thoroughbred race horses. J Equine Vet Sci. 2020;87:102935.

Slowinski J, Roszak M, Krawiec K, Henklewski R, Jamroziak K. Numerical analysis of stabilization of a horse's third metacarpal bone fracture for prediction of the possibility of bone union. Appl Sci. 2024 Sep;14(17):7976.

Soroko M, Henklewski R, Filipowski H, Jodkowska E. The effectiveness of thermographic analysis in equine orthopedics. J Equine Vet Sci. 2013 Sep;33(9):760-2.

Soroko M, Henklewski R, Jodkowska E. Analysis of thermographic, radiographic and ultrasonographic results in diagnosing orthopedic diseases in racehorses. Med Weter. 2012 Nov;68(11):693-6.

Soroko M, Howell K. Infrared thermography: Current applications in equine medicine. J Equine Vet Sci. 2018; 60:90-6.

Turner TA. Thermography as an aid to the clinical lameness evaluation. Vet Clin North Am Equine Pract. 1991 Aug; 7(2):311-38.

Zaha C, Schuszler L, Dascalu R, Nistor P, Florea T, Kalman I, Rujescu C, Sicoe B, Igna C. Evaluation of thermal changes

https://doi.org/10.17221/105/2025-VETMED

of the sole surface in horses with palmar foot pain: A pilot study. Biology (Basel). 2023 Mar 10;12(3):423.

Zielinska P, Soroko M, Howell K, Godlewska M, Hildebrand W, Dudek K. Comparison of the effect of high-intensity laser therapy (HILT) on skin surface temperature and vein diameter in pigmented and non-pigmented skin in healthy racehorses. Animals (Basel). 2021 Jun;11(7):1965.

Received: December 4, 2025
Accepted: August 17, 2026
Published online: November 18, 2026