Digital thermal imaging—Mapping the route to more complete diagnostics

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Digital thermal imaging (DTI) creates a visual image of the thermal energy being emitted by a patient. Differences in temperature at the skin surface are due to physiological differences in the underlying tissue and are a result of increased or decreased blood flow in the tissue.

The interpretation of digital thermal images relies on the premise that each patient has a distinct thermal gradient pattern related to their body’s physiology. Furthermore, the bilateral symmetry of the body allows one to interpret change in temperature between contralateral body areas to be a sign of potential pathology. In this way, the body acts as its own control, allowing visual (qualitative) and temperature change (quantitative) analysis of the physiological status of the patient. Consensus in the literature suggests an asymmetry greater than 1°C in at least 20 percent of the area of interest is significant asymmetry of the thermal gradient and warrants further investigation.1

The use of DTI in veterinary medicine is becoming more prevalent, as clinicians find it to be a valuable and practical tool for patient examination.2,3 In the case discussed here, thermal imaging was utilized for general health screening as part of a geriatric health examination, as well as mapping the route to further diagnostics. Overall, DTI contributed to a more accurate diagnosis.

Case report

A 10-year-old male, neutered, Labrador retriever was presented for a physical examination and quality-of-life assessment. He had recently undergone surgical removal of an anal gland carcinoma, and the owner was concerned about providing proactive, holistic care. As part of the physical examination, 14 thermal images were captured to assess the patient’s physiological status.

A thermal image of the dorsal neck showed multiple areas of asymmetrical hypothermia. This was more pronounced on the left side (Figure 1). Left and right lateral thermal images also showed multiple areas of hypothermia throughout the dorsal paravertebral musculature (Figure 2). Images of the forelimbs showed asymmetrical hypothermia in the distal limbs, with three distinct hypothermic areas in the left carpal region (Figure 3 and 4). Quantitative analysis of the carpal images revealed an average difference in temperature (ΔT) to be 4.7°C. Based on the physiological findings of asymmetry and a disruption of the normal thermal gradient, radiographs were recommended. Plain radiographs of the cervical spine showed narrowing of disc spaces C6-T1, suggesting disc protrusion. A presumptive diagnosis of cervical disc disease was made (Figure 5).

Following treatment, subsequent DTI during re-examinations identified improved harmony within the thermal gradients, which correlated well with improved quality-of-life assessment by the owner and clinician.

Discussion

When interpreting thermal images, hyperthermic asymmetry indicates areas of increased blood flow as a result of infection, malignancy, or inflammation. Hyperthermia is seen with muscle strain, sprain, joint inflammation, and wounds. Hypothermia, on the other hand, is associated with decreased blood resulting from vascular constriction, neurologic disease, muscle atrophy, or infarction.4 From a neurological standpoint, areas of hypothermia indicate possible symptomatic nerve compression, and warrant further investigation.5,7

In this case, the multiple areas of hypothermia visible on the dorsal and left and right lateral neck suggested a pattern of vasoconstriction correlating to dermatomes C4-C6. The forelimb images showed hypothermia in areas correlating to dermatomes C6-T1, with asymmetrical areas of greater hypothermia on the left distal limb compared to the right. In this case, the thermographic impression of cervical disc disease accurately corresponded with the radiographic impression.

To understand the significance of hypothermia when discussing infrared thermal imaging, we need to review the concept of dermatomes and their anatomy. A dermatome is an area of skin in which sensory nerves derive from a single spinal nerve root. A dermatome correlates to each single spinal nerve root; sensory information from a specific dermatome will be transmitted by the sensory nerve fibers to that specific segment of the spinal cord.

Dermatomes serve as a mapping system of the nervous system, with distal disease correlating to a specific cervical nerve root.8 In humans with nerve root impingement, the resultant radiculopathy (nerve root disease) leads to symptoms of pain, numbness, tingling, or weakness in the extremity. These symptoms can provide clues to support the use of further diagnostic imaging, such as radiographs or MRI of the spine.

Unfortunately, in veterinary patients, neuropathic pain associated with radiculopathy is underreported and often subtle. Some patients will exhibit only vague symptoms, especially with cervical disease. In this case, the patient had a normal neurological examination, but the thermographic examination offered insight into the patient’s physiology and overall health, leading to further exploration to establish a diagnosis and treatment plan.

Conclusion

Digital thermal imaging now provides an additional tool for use in the complete examination of patients. Veterinary clinicians can incorporate it into routine examinations and provide a more proactive and holistic approach to the assessment and management of patient health and well-being.

Case credit to: Dr. Marlene Siegel and Alyssa Siegel, Pasco Veterinary Medical Center, Lutz, Fla.

REFERENCES