Use of Thermal Imaging in Managing Injury in the Working & Performance Dog

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ABSTRACT

Over the past few years, there has been marked growth in the use and monetary value of dogs in performance sports such as fly-ball, agility, sled-dog racing, and sheep herding, as well as in working endeavors such as bomb & drug detection, search and rescue (wildland, structural, avalanche), and patrol/security. Thermal imaging can be a useful adjunct veterinary diagnostic tool in the detection of primary soft tissue injuries as well as in identifying any accompanying secondary compensatory stressors. Additionally, it can be useful in the monitoring of an animal's injury rehabilitation progression, helping to determine appropriate return to work and minimizing down-time or injury recurrence. This presentation will discuss a standardized and case-based approach to veterinary thermal imaging use in the performance and working dog.

INTRODUCTION

Thermal imaging has been around for decades, but did not start becoming practical and affordable as a medical tool until the advent of digital technology. For the veterinary practitioner, digital thermal imaging innovation means that now veterinarians have a practical, small, efficient tool to monitor *soft tissue* stress, function and injury. Typically in veterinary medicine, diagnostic imaging tools only evaluate structure that would look the same whether the animal were alive or dead (x-rays, ultrasound, MRI, CT). Thermal imaging is considered a physiologic imaging tool, since the image is dependent on the metabolic heat radiated by a live animal.

Sports medicine research with the equine athlete has shown thermal imaging to be very effective in not only identifying injuries in their prodromal phases, but also tissue damage not obvious to the examiner (due to masking by another injury). Very little research and clinical work has yet been done with thermal imaging in the performance dog, so the field is a blank slate with unlimited potential and possibilities for the canine sports medicine practitioner. The insulating ability of hair can sometimes be a problem, but information can still be obtained from the legs, face and ears. The author has scanned dogs with thick hair coats (see case below), and while the thermal information is not as definitive as it would be in a short-haired dog, enough information can often be gleaned from the image to beneficially guide the physical exam. Thermal imaging can give performance and working dog veterinarians an effective imaging tool for not only diagnosing an existing soft tissue injury, but also for monitoring post-injury recovery/rehabilitation and for early identification (and therefore, intervention).

THERMAL IMAGING IN THE DOG

In using thermal imaging on animals, it is important to remember exactly what the infrared technology is measuring in order to avoid artifacts and mis- or over-interpretation of an image. Remember that infrared thermal imaging is plain and simple, the viewing and measuring of surface heat. Measurable temperatures from the surface of a living creature can originate and be influenced from multiple sources. It can be radiated (from physiologic processes), convected by air currents, conducted by other warm surfaces, and altered by evaporation. For veterinary injury purposes, diagnosis is made from the radiant surface heat originating from the animal itself. In order to remove artifacts that can alter the value of the thermal information, it is critical that the veterinary thermographer manage the scanning environment to remove any convective, conductive, and evaporative factors which could alter the primary heat pattern radiated from the animal.

Metabolic heat from an animal is directly related to blood circulation; therefore heat will tend to follow the patterns of the blood vessels. It is critical that the veterinary thermographer have an excellent working knowledge of anatomy and understand where normal heat patterns would occur due to normal distribution of blood vessels. Dilation of blood vessels (increased use, decreased sympathetic tone, initial trauma) will result in increased blood flow and therefore a higher temperature thermal pattern. Constriction of blood vessels (atrophy, increased sympathetic tone, scarring) will result in a decreased temperature thermal pattern.

It is beyond the scope of this presentation to elucidate how to develop a specific protocol in scanning dogs. However, after several years of trial and error, the author has developed a standardized protocol for this particular veterinary practice and environment. In the horse, consistency in performing a thermal imaging exam is the most important part of creating a scan protocol. Thermography has been demonstrated in humans, horses, and dogs to provide reliable and repeatable diagnostic images (Tunley, Loughin). Care must be taken by the veterinary thermographer to make sure that environmental factors that can alter surface heat are managed. Imaging should be performed indoors, away from fans and sunlight through windows. Excessive handling or holding of the animal should be avoided and the animal should not be immersed in water for at minimum of 12 hours before a scan. The key to a good scan technique is consistency and constant awareness of the interaction of the animals' heat signature with the environment.

THERMAL IMAGING & SOFT TISSUE INJURIES

Currently, except with the exception of scintigraphy, veterinary diagnostic imaging is limited to techniques that evaluate structural changes without an ability to assess functional integrity. Studies in racehorses have shown that thermal imaging can detect the onset of tendon and ligament inflammation weeks before the horse shows gait abnormalities or structural changes identified via ultrasonography. Although there are currently no equivalent studies in dogs, especially since ultrasonographic evaluation of canine ligamentous and tendinous structures is itself in its infancy, the current assumption is that dogs too will demonstrate similar injury thermal patterns, although on a scale proportional to their smaller body size.

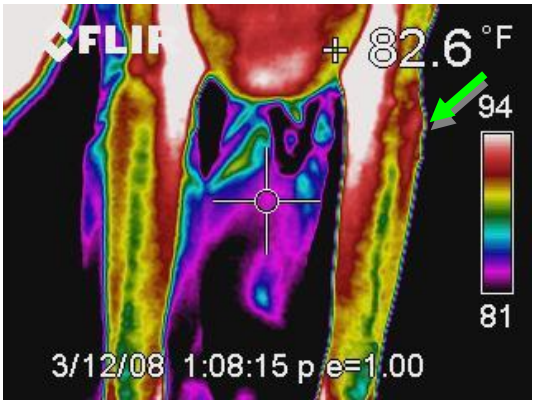


Figure 1: Anterior front legs of a Doberman showing lameness after jumping. Note the increased thermal pattern of the left elbow (green arrow-right side of image). Radiographs were used later to diagnose a torn lateral collateral ligament of the left elbow.

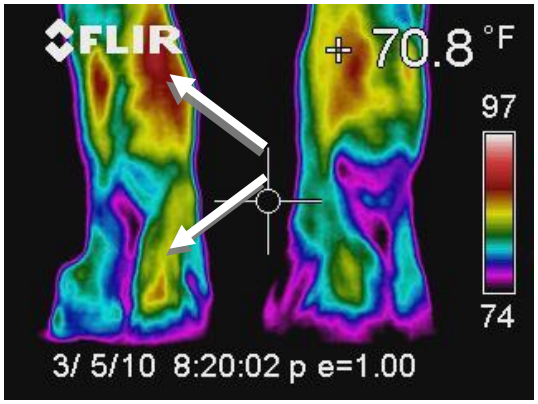


Figure 2: Posterior (palmar) view of a sled dog's front feet; the dog had caught its foot in a neck line the previous day. Note increased thermal pattern of left medial carpus and tendon pattern of 3rd digit compared to the right (arrows). Diagnosis was carpal synovitis & tendon sheath inflammation.

Hematomas or seromas can show a cold pattern for the first 48-72 hours post-injury. After this period of time, the inflammatory, vasodilatory effect will result in a heat pattern with a distinctive edge that is often very painful on digital palpation.

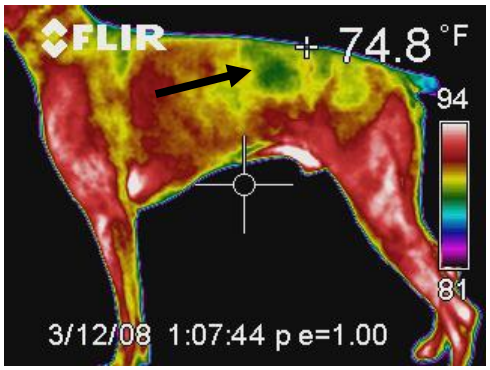


Figure 3: Left torso of a Doberman who had a recent body-slamming incident with another dog. The owner complained that the dog cried out when its back was touched. Note the cooler (green), circular area in the anterior lumbar area (black arrow). Physical exam revealed a fluid pocket from a hematoma.

THERMAL IMAGING & HARNESS FIT

A large segment of working dogs must wear a harness. Sled dogs, avalanche, SAR, draft, and service dogs must wear some type of body harness, not only for identification and restraint, but also to assist in moving the dog into and out of helicopters, boats, aircraft, and structural ruins. Additionally, there are many paraplegic animals who wear harnesses attached to carts for mobility. To date, there has not been any research into the ergonomics of harness fit in dogs, although there have been a few papers published using thermal imaging to determine saddle fit in horses and a single case report using it to evaluate fit of a prosthetic tail in a dolphin. In 2009, the author performed a small study (currently in peer-review) on a group of avalanche dogs, evaluating harness fit after a day of field avalanche search work which included hot-loads into helicopters, searching and indicating in snow fields, and a steep, multi-mile run to return to base. The findings showed that not only were there many problems with harness fit in these dogs, but also that many of the heat patterns caused by ill-fit lasted for more than 12 hours.

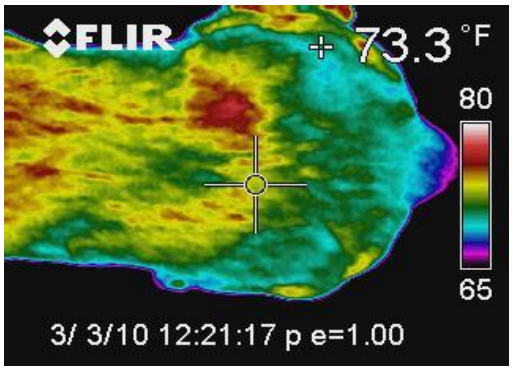


Figure 4: Dorsal lumbosacral spine of an Iditarod sled dog (tail is to right) 24 hours after a 4 hour training run. Note asymmetrical heat pattern with concentrated heat pattern over right (top) ileal crest (which was sensitive to palpation).

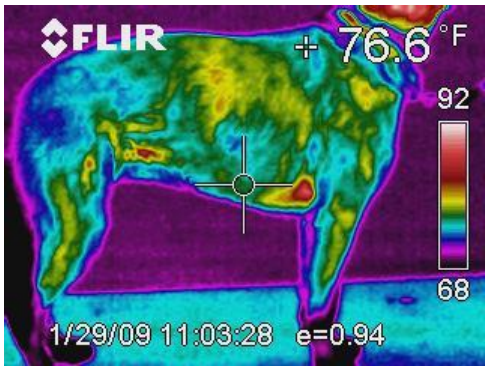


Figure 5: Right torso of an avalanche rescue dog the day after a field training session. Note asymmetrical heat pattern still present almost 24 hours after working in harness. No obvious rub marks were present.

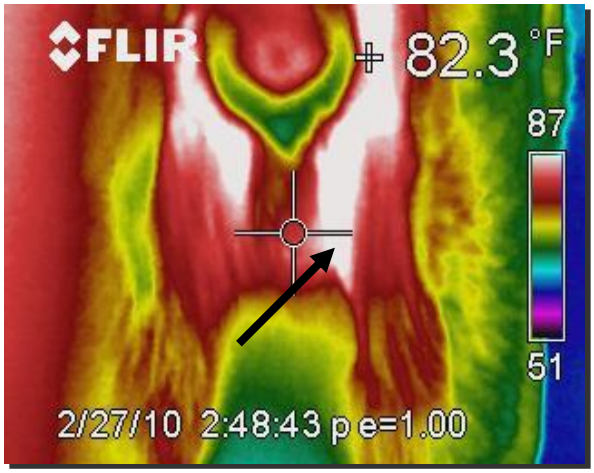


Figure 6: Groin of a FEMA structural Search-and-Rescue (SAR) dog. The dog sustained a severe tear of the left gracilis muscle (arrow) working in deep snow.

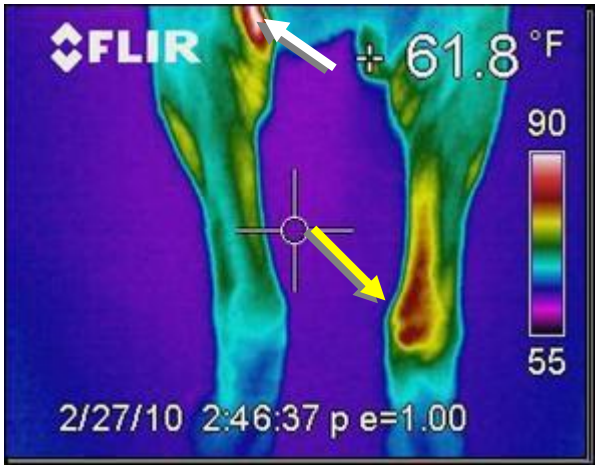


Figure 7: Posterior hind legs of FEMA SAR dog. The inflammation from the torn gracilis muscle can be seen in the upper left (white arrow). However, due to compensation, the right Achilles tendon is starting to show inflammatory changes (yellow arrow), even though no swelling or lameness on right hind is evident on physical exam.

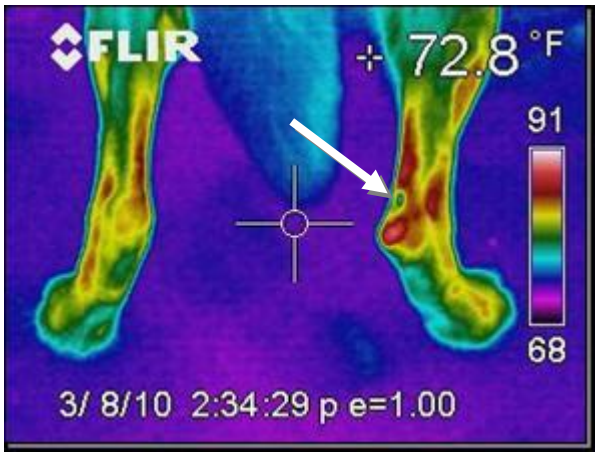


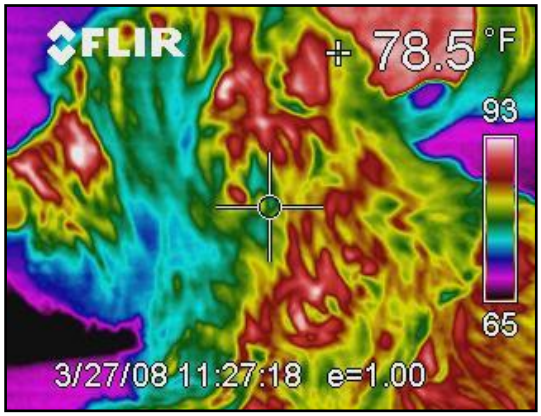
Figure 8: Posterior hind legs of FEMA SAR dog 9 days later. Note that thermal heat patterns of hind legs are starting to equilibrate. There is a cooler (green) moisture artifact present on right Achilles tendon (arrow).

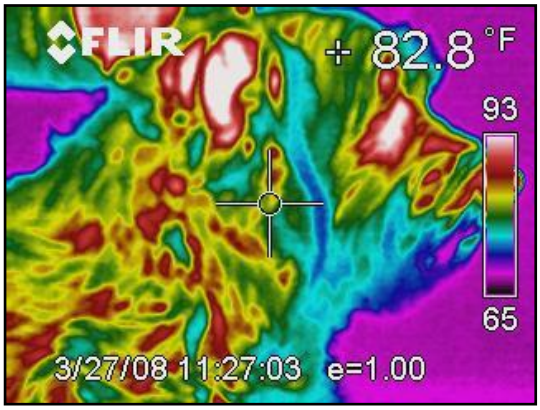
THERMAL IMAGING'S ROLE IN REHABILITATION

Cross-over training of human physical therapists and veterinarians in post-operative and post-injury canine rehabilitation is becoming standard of practice. Thermal imaging provides a useful tool for veterinarians and rehab technicians in monitoring an animal's progress in rehab and can assist in individualizing protocol. Sudden changes in normal heat patterns or increased asymmetry in heat patterns between limbs can be early warning signs that rehabilitation is progressing too fast or that another compensatory injury may be imminent. Additionally, high drive dogs, especially those that might have pain masked by the aggressive use of anti-inflammatory medication, may not show signs obvious to either a handler or the veterinarian that another injury is present or regression has occurred. Regular monitoring with thermal imaging can help catch problems before they occur and allow the veterinary rehabilitation specialist to modify a particular protocol for the individual.

HAIR COAT

One of the most difficult problems when scanning dogs is dealing with hair coat. For dogs with long hair or double coats, it can be difficult to attain significant information with thermal imaging. However, it never hurts to look. As long as the difficulties associated with reading through a highly irregular and/or insulative material are kept in mind, the savvy and competent thermographer can still find some information that can be meaningfully used in a physical exam. A technique the author has developed in long-haired dogs is to perform a scan, finger groom or fluff up the coat, and scan again. Artifacts of normal radiant heat escaping through breaks in the coat will not consistently repeat. Abnormal heat patterns will continue to repeat in the same area no matter how the hair is brushed or altered. Additionally, undercoat hair loss from collar or harness rubbing can be difficult to spot when initially examining a dog for any changes that could alter a thermal scan. If any odd (especially linear) thermal pattern should appear, the veterinary thermographer should make a note and carefully reexamine the area for any wear or loss of hair coat from rubbing, scarring, or clipping.





Figures 9 and 10: Lateral views of the cervical region of a Cairn terrier with neck pain after falling off of an agility A-frame. Note that even with the thick hair coat, the left side of the neck (Fig 9) demonstrates a warmer heat pattern than the right side (Fig 10).

SUMMARY

Thermal imaging has been demonstrated to be an effective and reliable diagnostic tool in the detection of soft tissue injuries and in the monitoring of rehabilitation in performance and working dogs.

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ABOUT THE AUTHOR

Kimberly Henneman, DVM, FAAVA, CVA, CVC graduated from Purdue's School of Veterinary Medicine in 1986 and has been using complementary therapies with a sports medicine emphasis since 1990. She is certified in acupuncture (IVAS '91), chiropractic (AVCA '93), Chinese Herbal medicine, and has advanced training in classical veterinary homeopathy. She has been using thermal imaging since purchasing her first analog Agema camera in 1995. Her practice covers 9 states, from New England to the Southwest to the Rocky Mountains to Hawaii. She is currently secretary of the Veterinary Thermal Imaging Society.

Her equine patients include backyard babysitters, international FEI dressage, show jumpers, reiners and eventers, old ranch hands, and Thoroughbred/Quarter Horse race horses. Her canine patients run the gamut of competitive sheep dogs, agility, fly-ball, police, explosives, avalanche, and Search-and-Rescue.

At the 2002 Winter Olympic Games in Utah, she was the veterinarian for the Budweiser Clydesdales and organized the first-ever Service Animal Sports Medicine Center which used thermography and integrative therapies to maintain the health and function of the security patrol horses and explosives/patrol/SAR/ avalanche dogs. She has accompanied members of the USET's Endurance Team to the World Equestrian Games in Spain and the World Championships in Dubai. She has chapters in several veterinary textbooks and has written for or been quoted in magazines such as *Dressage Today*, *Equus*, *Practical Horseman*, *Horse Illustrated, Mushing,* and *Western Horseman*. She lives in the Rocky Mountains with her husband and their household of dogs, cats and horses. In her spare time, Dr. Henneman competes with her Holsteiner gelding in 3-Day Eventing or skis.