

# **The Value of Infrared Thermography in the Diagnosis and Prognosis of Injuries in Animals**

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## **ABSTRACT**

In veterinary medicine, as in complimentary human medical disciplines, it is often difficult to make the proper diagnosis because of factors such as changing symptoms or the lack of diagnostically recognizable symptoms. The search for answers in such situations, coupled with the patient's inability to communicate, is often frustrating to the veterinarian and costly to the client. The result is that such elusive problems frequently go undiagnosed for long periods of time.

Infrared thermography enters into the diagnostic arena with such a problem and we suddenly have a different perspective on the entire situation. After using an infrared thermal imaging camera to take an infrared scan of the patient, we have reliable information on the potential location of the problem, and can then focus the majority of our diagnostic effort on that particular suspicious area of interest. The client benefits because progress is being made with manageable costs; the veterinarian benefits by being able to plan the correct diagnostics and subsequent treatment while maintaining professional credibility. All parties have benefited from the introduction of thermography by using an infrared thermal imaging camera into the process-and most of all, of course, is the benefit to the animal patient.

Once treatment has begun, with the use of an infrared thermal imaging camera to monitor the treatment process, the veterinarian can make any changes necessary at the appropriate time, and therefore, the patient will receive the most efficacious and humane treatment and will recover in the shortest possible time.

This paper will present a number of demonstration cases on cats, dogs, and horses, where thermography was used to aid in the proper diagnosis and resulted in the proper assessment and prognosis of the animals involved.

**Keywords:** infrared thermography in horses, equine thermography, veterinary infrared thermography, animal infrared thermography, veterinary IRT, animal IRT, veterinary medicine and infrared thermography, animals and infrared thermography, veterinary thermography, animal thermography, animal injuries, veterinary diagnostics, veterinary treatment monitoring, animal diagnostics

## **1. INTRODUCTION**

The use of infrared thermography in veterinary medicine could be described as "something new about something old." It's use in the veterinary discipline has been practiced since at least the 1960's, but it is only now, in approximately the last 5 years, that it has been viewed with a reasonably open mind in the veterinary community at large. In the early days when veterinary thermography was an infant, mistakes were made, as is going to be true in any new discipline. A great deal of new knowledge was gained from those early efforts, and as faithful veterinary researchers continued to use and improve on that knowledge, a body of information developed on the proper use of IRT in animals. As veterinarians using IRT, we still have much to learn and improve on, but we also have a sound basic understanding of how to better go about gaining that new knowledge with our goal being to expand the veterinary medical uses of IRT and its perceived creditability in the medical community at large. The pioneers of animal thermography are at last seeing their efforts to educate their colleagues become fruitful, which is a blessing not only to the researchers themselves, but also to the animal patient and its owner. The challenge now, is to get veterinary practitioners to use thermography at the proper time, and for the proper reasons, so that its value can be maximized. We live in a society where time and money are in short supply for most people. The proper use of infrared thermography in veterinary medicine can mean a substantial savings of both of these valuable resources, and more effective and humane treatment for the animal patients on which it is used.

There are three primary areas where IRT is currently useful in veterinary medicine; those areas are:

1.) preventive medicine; 2.) diagnostics; 3.) treatment, prognosis, and rehabilitation. We will consider these areas one at a time, expanding on each area to present its potential.

## **2. PREVENTIVE MEDICINE**

This is an area of great potential, but unfortunately, it is also currently the area where IRT is being used with the least frequency. There are pet owners who want to give their pets the very best of everything, and that includes health care. There

are also athletic animals that are competing for honors and awards-i.e. championships in various divisions of superior athletic performance, or prizes-i.e. new automobiles or dream vacations (for the owner), and prize money-i.e. in horse racing, millions of dollars can be at stake in a single race--- and the list goes on. Athletic animals are usually under an extraordinary amount of physical and mental stress, just as are the human athletes that are their counterparts. It can be difficult for the owner to pick up on subtle physical changes in the best of circumstances, let alone in the unusual ones that often involve constant traveling across country by motor vehicle, or in today's fast paced world, we find that these athletic animals often travel around the world to compete, thus becoming "frequent fliers" just as their human counterparts do also. It should be easy to see the part that IRT can play in keeping these animals at the top of their game, which is what is needed if they are to achieve the goals that their owners have set for them. There is also that client who thinks that his or her pet is actually a child substitute, and such people are often in constant concern over the health of these surrogate children. In all of these situations, infrared imaging can provide an important part of the answer to monitoring the health of the animals involved and therefore providing a valuable service to their owners. We are aware that infrared imaging can detect a subtle injury several weeks before the human eye or hand has the ability to see or feel that injury. We also know that the thermal imaging camera will "see" a potential problem weeks before the animal itself shows symptoms such as swelling or lameness that are commonly relied upon to tell owners and trainers when a physical problem is occurring in the animal. It has been my experience that *you can do an excellent job of monitoring health in an animal by combining the use of infrared imaging and blood work-ups on a regular basis.* For a pet animal, this might mean repeating this preventive regimen every 3 to 6 months, depending upon the owner's anxiety over the pet. For the horse that is in a high level of competition, particularly when speed is involved, that should mean every 2 to 4 weeks as well as before and after each race or other high stress athletic event. With the amount of purse or prize money that is at stake today, we are doing both the animal as well as the owner/trainer, a favor to suggest this type of preventive program. They will come much closer to achieving the goals and dreams hoped for, if subtle injuries can be reversed before they escalate into injuries that stop training or competition "dead" and everything is lost. I don't believe that we can overstress the importance of the use of IRT as associated with injury prevention in animal athletics or in general monitoring of the health status of the individual pet or competitive athlete.

### 3. DIAGNOSTICS

When we don't succeed in our attempts at convincing clients to use good preventative practices in the care of their animals, as well as when unavoidable injuries occur, we "change hats" and become diagnosticians. This is actually the part of veterinary medicine where IRT is receiving the most notice and getting the best current reviews. In addition to being the area of highest use of IRT in veterinary medicine, diagnostics is also the area where it is being the most ineffectively used. This error in use is related directly to the *time*, in the diagnostic process, that owners/trainers/ or veterinarians are choosing to do IRT imaging. Much too frequently, IRT is being used after other diagnostic procedures fail to produce satisfactory results in rendering the correct location of a subtle problem. Likewise, other diagnostic procedures may have failed to provide any practical information that could lead to the exact location and proper treatment of an injury that is already showing visible symptoms, but not actual diagnostic signs related to a commonly recognized location for the injury. An example is an animal that is definitely lame in a limb, but does not show any soreness upon palpation of that limb. Another example would be a horse that is lame, but that lameness is either appearing to be in several legs at once, or is giving the appearance of changing legs. Where is the actual injury---or, is more than one physical location involved? *Because one of the most valuable benefits that IRT provides in diagnostics is the accurate location of injuries, it should be used after a thorough physical exam has been performed, but before other diagnostic means are employed.* This proper timing of the use of IRT in diagnostics, saves time for the veterinarian/owner/trainer, money for the owner/trainer, and needless suffering for the animal. When a veterinarian includes the early use of IRT in the diagnostic plan for an animal, he/she is ensuring that the injury won't go undiagnosed for a long period of time while the patient suffers, and the client frets over the irritation of the mounting diagnostic cost which have produced no firm answers. As a veterinarian, I can assure everyone that clients will usually try to "cut corners" on diagnostics more than on any other part of the cost necessary to produce the best recovery from the injury. The early use of IRT is one of those win-win situations that everyone should appreciate. Once the location of the injury or injuries has been documented by IRT, it is time to use other diagnostic methods, such as X-ray or ultrasound or CT scans etc. At that time in the diagnostic process, these other methods can be of definitive value in providing more specific information about what has actually gone wrong at each suspicious location that was pinpointed with the IRT scan. Overall, there are significant savings of time and money because costly procedures weren't performed at the wrong locations and the money spent should be productive if the veterinarian chooses the right follow-up diagnostic procedures, and those procedures are carefully performed and properly evaluated.

I want to make a special point of cautioning everyone that things are not always what they first appear to be. I have seen horses with extremely sore backs that were almost instantly healed when IRT revealed that they had problems in their feet; as soon as the foot problems were properly taken care of, the backs were no longer sore. For obvious reasons, I feel it is best to

scan (image) the entire animal, and then do a thorough evaluation of those scan images to determine, if possible, where the primary problems are. Once the primary problems are corrected, you may find that the animal no longer has some of the secondary signs that were originally seen. Don't get in a hurry and try to resolve everything at one time; go step by step, using continual IRT monitoring to help evaluate changes, and tailor your treatment to those changes. In today's world, we live in a society where there is a perpetual demand for the "quick fix", but when we deal with living systems such as we do in medicine, it is often wise to let the patient show us what time schedule will work best to accomplish the desired result of a complete return to good health and useful soundness.

Infrared thermography is an excellent diagnostic tool no matter when it is used, but its use at the most beneficial times in the diagnostic process, provides the ability to insure the best outcome for even the most diagnostically challenging cases. Once the diagnostic process is complete, IRT can then help to provide valuable information about the ongoing healing process, and therefore, allow us to do the most effective job we can, in treatment of the patient. Just as important as diagnostics and treatment, is the information that we gather through the use of IRT, which allows us to correctly advise all parties on the prognosis which is the potential or probability that the patient will actually return to good health and soundness as desired.

#### 4. TREATMENT, PROGNOSIS, AND REHABILITATION

When we institute a treatment regimen, we have to continually monitor the patient's progress from that treatment scheme. We often need to make changes in the treatment as the case progresses toward the desired healing result. Experienced practitioners can interpret progress by means of keen observation of the injury, as well as more subtle signs that relate to the "art" of healing. But despite experience and that illusive "art" that the practitioner uses, there are times when one needs every bit of scientific information that is available, to make a good decision about the status of a patient, and the possible need to make some change in the treatment being administered. This is another place that infrared imaging can often be of value to the veterinarian. IRT is a great tool for evaluating circulation or blood flow to a given area; we will use it as an example of how IRT helps veterinarians to make good treatment decisions. There are times when a treatment regimen is pointed toward increasing circulation to an anatomical area, and other times when a decrease in circulation is the desired result. By using ITR to monitor a given area of the body, we can quickly see if our treatment is producing the desired circulatory change or not, as well as become aware of circulation changes that we might otherwise miss until a much later time. An example of an unexpected circulatory change is the ischemic death of tissue around a wound or surgical incision. If we see such a decrease in circulation beginning to occur, we may be able to minimize the amount of tissue that is lost, or at worst, plan ahead for the result of that tissue loss. As the veterinarian monitors the progress of the treatment, he/she also begins to get an understanding of the probability for whether a complete return to health and soundness will occur or not. Based on that probability, the veterinarian is able to give the owner a prognosis of the animal's chances to return to a full or normal activity level and an approximation of the recovery time that will be necessary to achieve that return to normal. As the recovery progresses, the veterinarian may change the prognosis with respect to the patient's changing response to the treatment. Being able to correctly estimate recovery time, and the probability of a return to normal or intended athletic activity, is very vital information that is needed by owners and trainers so that they can make economic as well as personal decisions that relate to the animal's future. Animal owners are people, and people are visual creatures: *a client can be more easily convinced to be patient when the veterinarian can demonstrate the progress being made because he/she has a printed copy of the color images that resulted from the latest thermal scan.* To quote a wise old proverb, "seeing is believing" and that truism could not be more accurate than when applied to helping a client maintain patience and hope. Once again, infrared imaging is a tremendous help in providing us with accurate information that will help all parties, involved in each case, make the best decisions. How is treatment progressing? Are all areas responding as desired so that a return to work will be possible? How long does it look like it will be before we can begin to start training this animal again? Are we allowing enough time for each phase of the recovery process in this animal? Are we going too fast in this particular phase of the rehabilitation process? Can we gallop him tomorrow? If not, how about next week? These are just some of the questions that IRT helps us answer correctly for our client and the patient. Without IRT to help us in the evaluation of the healing process, we are giving the owners our best guess and nothing more. With IRT, we are giving the owners good, solid, scientifically documented evidence on which we can all base the best possible prognosis and plan for recovery, as well as to accurately monitor that plan as we implement it. *The patient deserves the best care that we can feasibly provide, and IRT is a vital tool in helping veterinarians provide that level of care consistently, and to the best of our medical ability.*

#### 5. CASE STUDIES

- Case #1---Intervertebral Disk Disease (IVD) in a Dog
- Case #2---Ruptured Anterior Cruciate Ligament in a Dog
- Case #3---Examples of Tissue Death in Two Dogs
- Case #4---Laminitis and Unequal Muscle Development in a Horse

Case #5---Sore Back, Laminitis, and Navicular Bursitis in a Horse

Case #6---Reflex Sympathetic Dystrophy in Two Horses

Case #7---Ringbone and Sidebone in a Horse

Case #8---Paralysis in a Cat

### CASE # 1---IVD in a 5 Year-Old Springer Spaniel

This dog had painful symptoms that indicated Intervertebral Disk Disease (IVD) for 6 months, but all X-rays that were taken showed normal skeletal structure without degenerative changes when they were examined. The owner was frustrated with the veterinarian's inability to demonstrate and confirm the diagnosis. The problem was resolved when an IRT scan (Fig.1 left) confirmed inflammation at two different locations on the dog's back so that the diagnosis of early IVD was definitively made and efforts to find other causes for the pain were unnecessary.

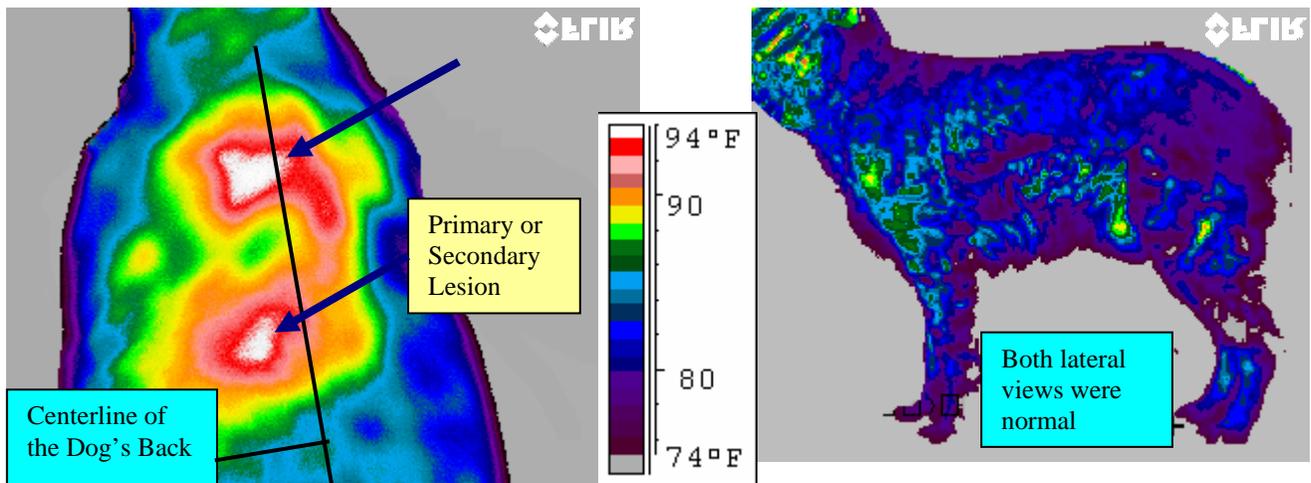


Figure 1. IRT scan (left) confirmed inflammation at two different locations on the dog's back

### CASE #2---Ruptured Anterior Cruciate Ligament in a Pit Bull Dog

This dog had a lameness of several weeks duration. Examination by the veterinarian revealed pain in the left femero-tibial joint (stifle). Thermal images (fig.2.) confirmed the loss of a normal thermal pattern on the left side, as well as an increased temperature in that joint as compared to the opposite right femero-tibial joint. These thermal changes are consistent with a ruptured anterior cruciate ligament, and surgery was performed to repair the ligament. (Note: Similar thermal patterns may be seen with other injuries of the stifle joint, and careful physical examination is helpful in determining the final diagnosis.)

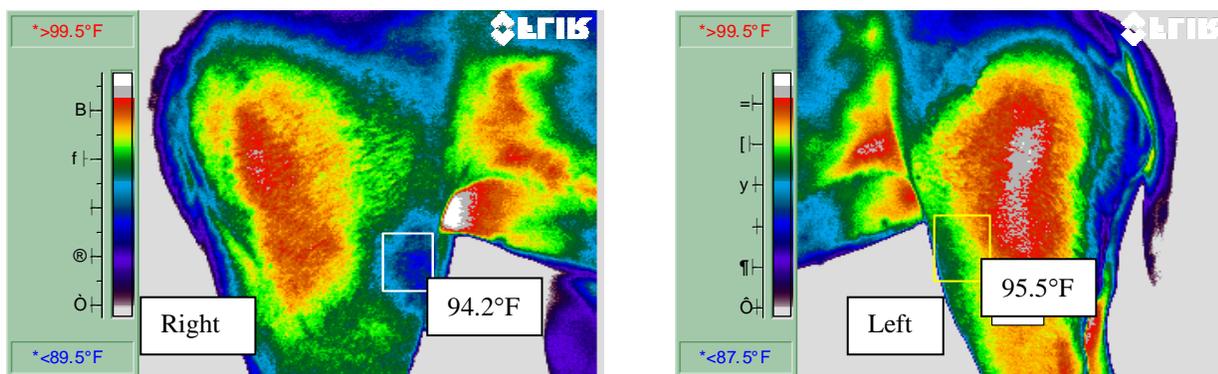
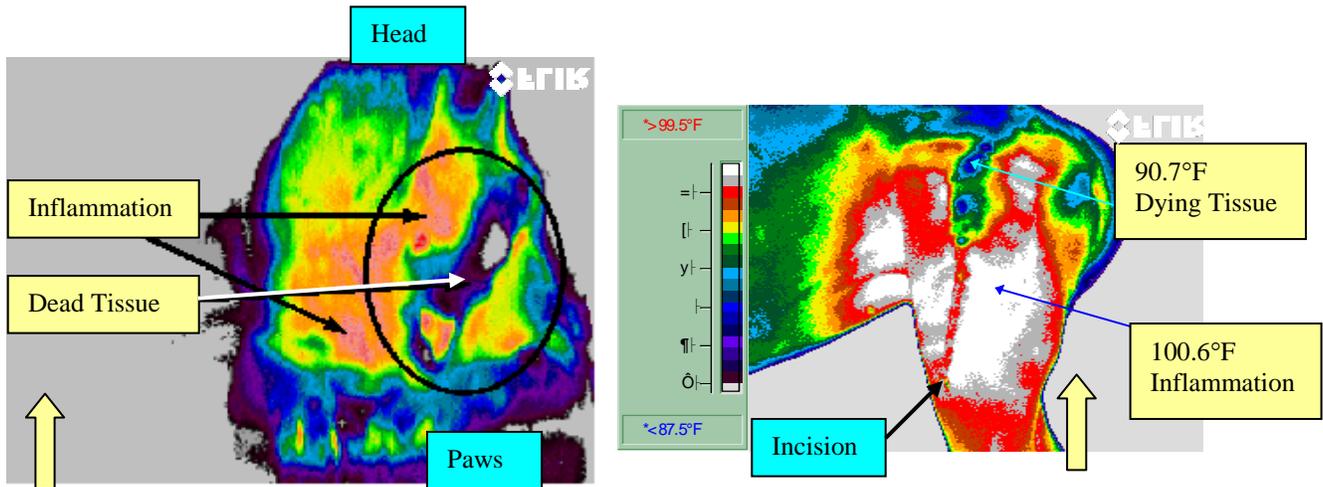


Figure 2. IRT scan shows increased temperature and abnormal pattern on the dog's left side

**CASE #3---Examples of Tissue Death in Two Dogs**

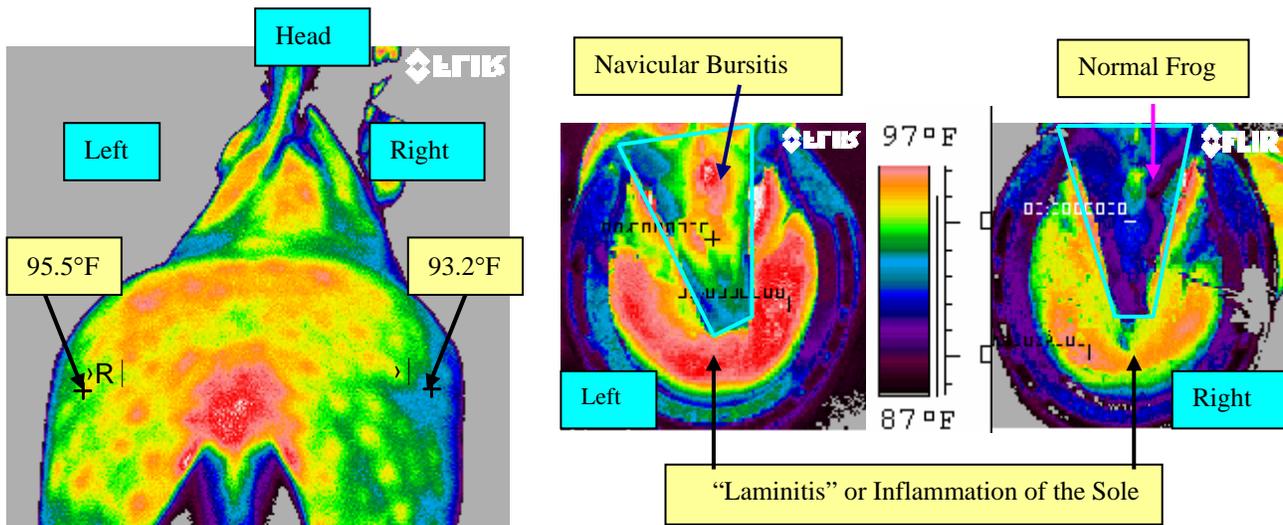
Fig. 3 illustrates two cases that show the use of IRT to evaluate the condition of tissue as indicated by the temperatures associated with that tissue. Changes in circulation will create changes in tissue temperature and therefore increased or decreased temperatures can be used to evaluate circulation in a given area. Inflammation will be associated with increased circulation and increased temperatures, whereas a lack of circulation, known as ischemia, will be associated with decreased temperatures. Tissue death can result from temperatures (or the related circulatory changes) that are too high or too low.



**Figure 3 Seroma & chest wound on a dog (left) and post surgical evaluation of the dog discussed in CASE #2 (right)**

**CASE #4---Laminitis and Uneven Muscle Development in a 5 Year-Old Gelding**

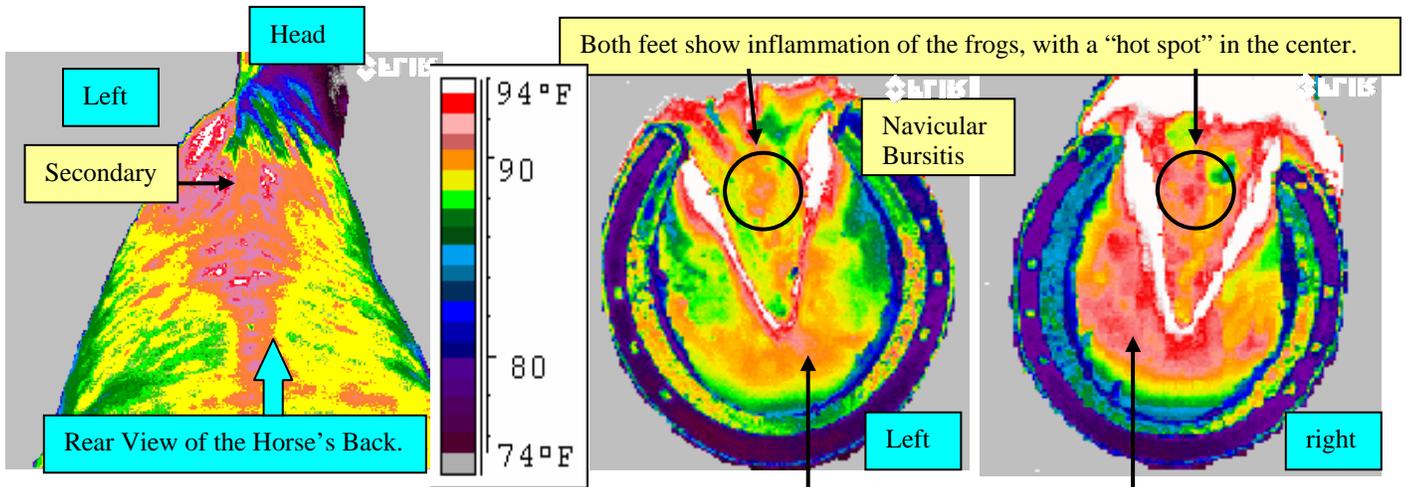
This horse was used as a flat horse by its owner. The horse was being treated by a veterinary chiropractor but the owner was dissatisfied with the progress being made and wanted another opinion because she hoped to eventually use the horse over fences as a hunter. Thermograms in Fig.4 revealed two problems 1.) Uneven muscle development with the right side of the horse being underdeveloped; 2.) Laminitis in both front feet. Proper shoeing of the feet and a change in the training program to emphasize working the horse primarily to the right made a difference in this horse within a few weeks.



**Figure 4. Thermograms show uneven muscle development (left) and laminitis in both front feet**

**CASE # 5---Sore Back-Laminitis-Navicular Bursitis in a 5 Year-Old TB Gelding**

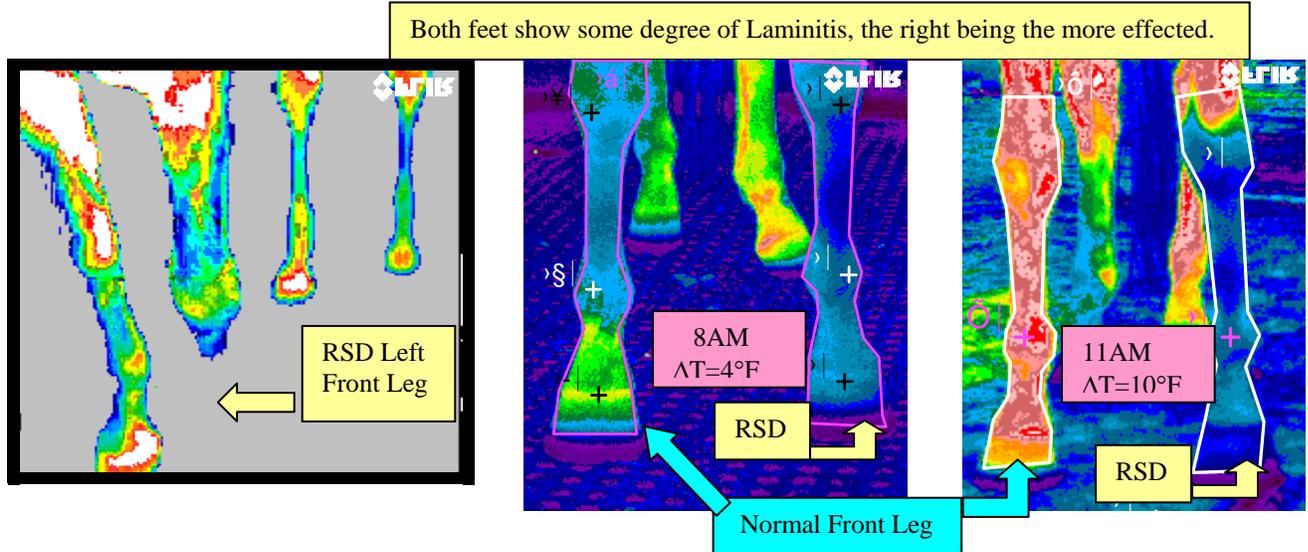
Thermograms in Fig. 5 were taken of a gelding whose back was so sore that just laying a lightweight saddle on his back would make him go almost to the ground. When closely examined, he was found to have inflammation in his feet. This was particularly significant in the front feet in the area of the frogs which overlay the navicular bursas. Pulling some nails out of three of his four shoes (they aggravated the problem by applying pressure) and correcting the angle at which he was shod, provided instant relief to this horse and he was no longer sore in his back.



**Figure 5. Thermogram of gelding's back shows soreness resulting from inflammation of frogs on both front feet**

**CASE #6---Reflex Sympathetic Dystrophy In Two Horses**

In the field of human medicine, there is a syndrome known as "Reflex Sympathetic Dystrophy". Although it has not been reported to exist in other species, with the advent of the more frequent use of IRT in animals, we believe that we are seeing a similar syndrome in horses. The syndrome is characterized by a  $\Delta T$ , between the affected leg and the normal opposite leg, of 7°F (5°C) or greater (see Fig. 6). Often, the hotter the atmospheric temperature, the greater the  $\Delta T$  (if you image the horse at

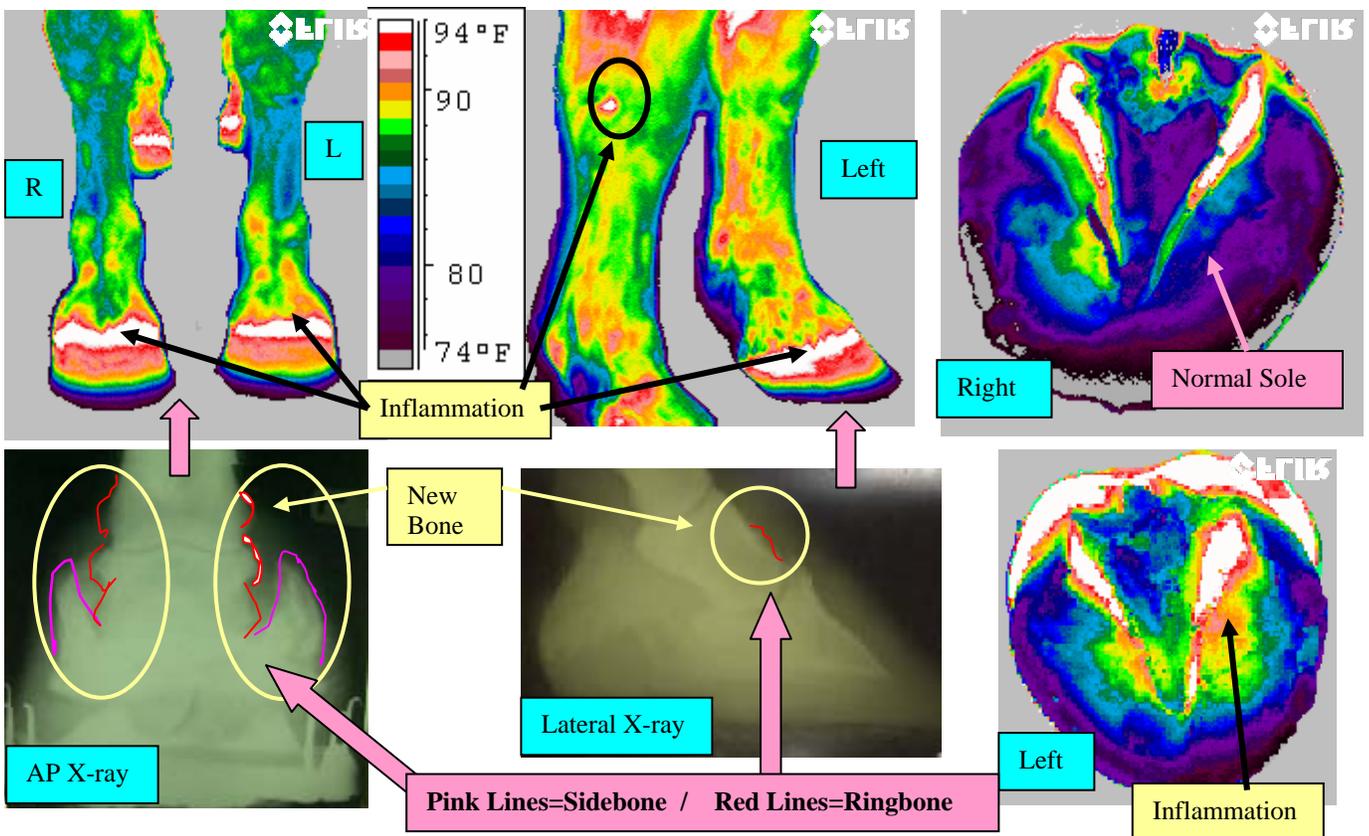


**Figure 6. Thermograms indicate symptoms of Reflex Sympathetic Dystrophy**

6 AM, and again at 11 AM, the  $\Delta T$  will increase with the temperature) so that it is important to consider the time of day when the images are taken, in order to make a definitive diagnosis of this condition. (It may be necessary to re-image the animal at a different time of day). The owner often wants the horse scanned because it has a persistent lameness that followed a minor injury to a leg; after the minor injury was treated and apparently healed, the horse continued to be lame. Often the horse has been X-rayed and/or ultrasounded without any significant findings having resulted and the owner is perplexed and distressed.

**CASE #7---Ringbone and Sidebone in a Police Horse**

This 7 Year-Old Percheron Gelding was a mount in a mounted Police Patrol Unit. He was lame in both front feet, the lameness was more pronounced in the right front. The referring veterinarian had X-rayed and ultrasounded the patient in attempts to locate the major cause of the lameness. X-rays showed the presence of both ringbone and sidebone but the veterinarian decided to use IRT to image the horse to see if anything was being missed. IRT scans (Fig. 7) showed an area of increased thermal activity on the lateral side of the right carpus (knee). When the area was palpated and showed soreness, but there were no bone changes found when it was x-rayed. The most probable explanation for the hot area was inflammation of a collateral ligament in that location. The prognosis for this horse is considered to be poor because of the magnitude and type of changes that were demonstrated on the X-rays, and the degree of inflammation seen on the thermal images.



**Figure 7. Thermograms and X-rays indicating the presence of both ringbone and sidebone**

### CASE #8---Paralysis in Cat

This cat was shot with a pellet gun and had undergone surgery to remove the pellet about 14 months (X-rays, Fig. 8, right) before the thermal image (Fig. 8, left) was taken. The cat had remained paralyzed since the accident and had shown no response to treatment. The IRT images showed no inflammation at the surgery site and a poor prognosis was rendered because there was no evidence for potential improvement in this patient.

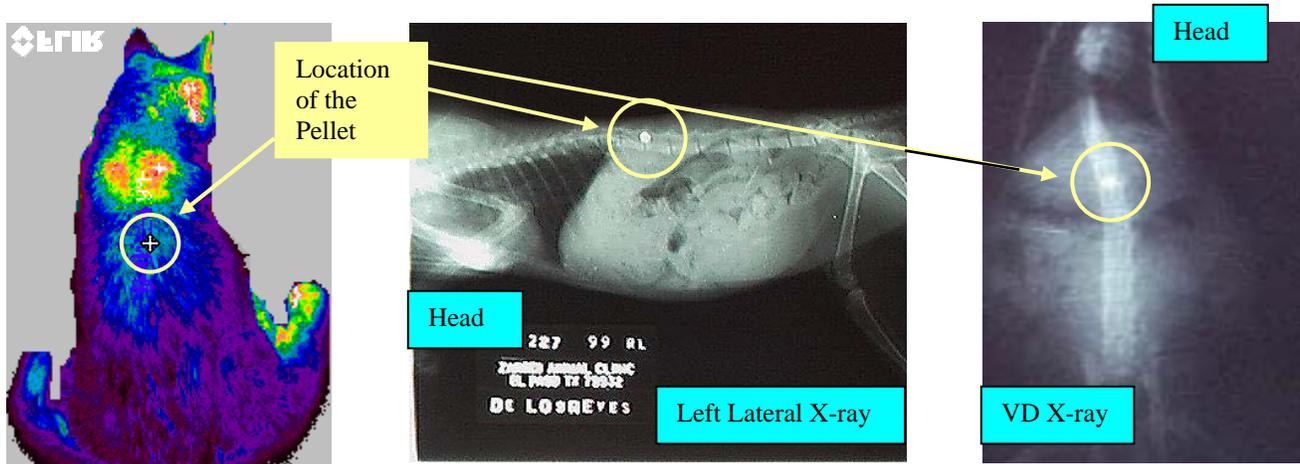


Figure 8. Thermogram (left) and X-rays (right) of a cat wounded with a pellet gun

### 6.SUMMARY

Infrared thermography is not new to veterinary medicine, but despite that fact, veterinarians are just beginning to understand the potential applications and benefits that it offers when used to evaluate, treat, and rehabilitate their patients. Even more critically, veterinarians and their clientele need to gain a greater understanding of the value that IRT offers in the field of preventive medicine. We are all aware that it is better to prevent a problem than it is to treat that problem after it develops. As veterinarians and thermographers, we can promote the recognition of IRT as an important medical tool by educating those with whom we have contact. We need to make others aware of the untapped potential of IRT that will be revealed as it is more frequently and properly used to aid in the entire medical process that unfolds when an animal is injured. IRT is invaluable in the diagnosis, treatment, prognosis, recovery, and rehabilitation of each patient on which it is used as has been shown in the case studies that are used as examples in this paper. We live in a culture that creates the need for conservation of time and economic resources. We want others to know that IRT offers a practical way to conserve these resources when it is wisely used by veterinarians in the care and treatment of animals, particularly in the prevention, treatment, and rehabilitation of injuries in valuable athletic animals.