Thermography of the Hoof
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Example De-shoeing

Thermography is the graphic display of the surface temperature of an object. Inflamed or damaged tissue that has an increased metabolism and an increased blood circulation, can be detected as warmer areas, if the blood circulation is not obstructed. Decreased blood circulation and/or reduced metabolism result in lower surface temperatures.

The thermographic pictures were recorded with an infrared camera

FIG. 1: EXAMPLE FOR THERMO GRAPHIC PATTERN OF A HEALTHY UNSHOD HOOF

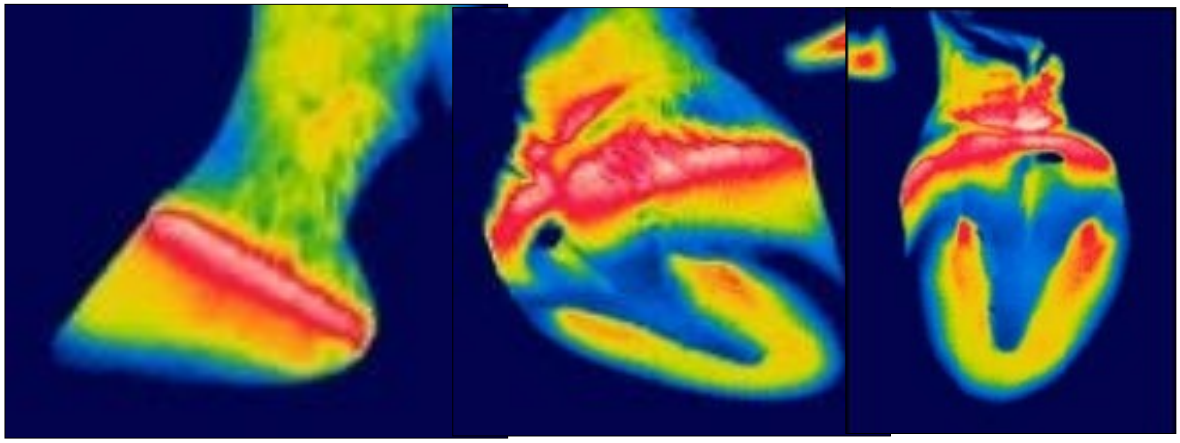


FIG. 2: EXAMPLE FOR THERMO GRAPHIC PATTERN OF A SHOD HOOF

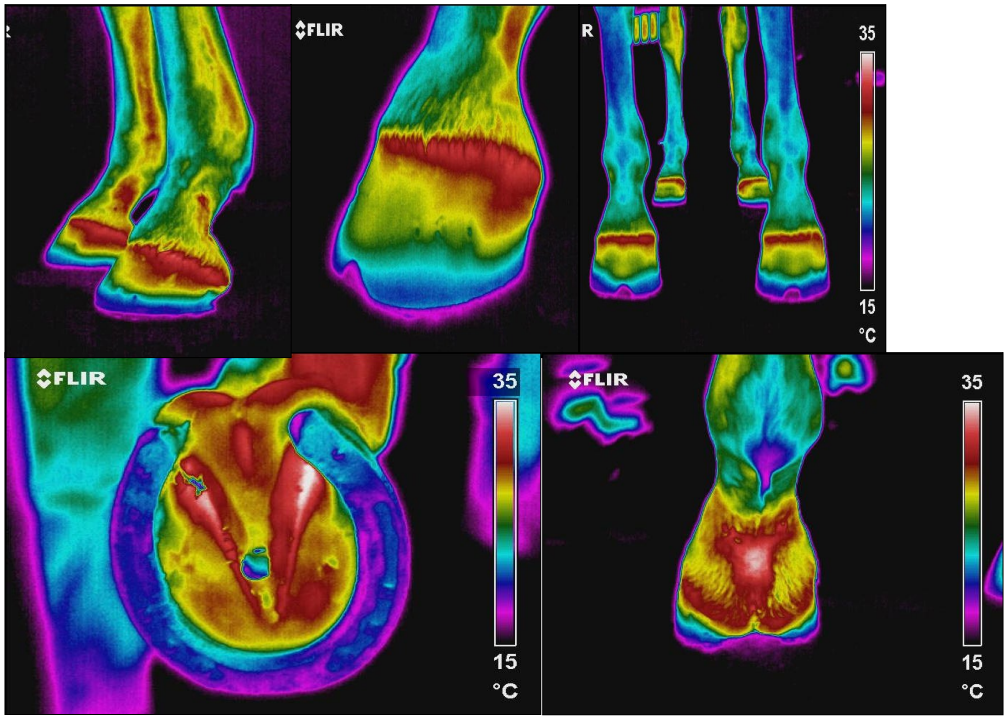
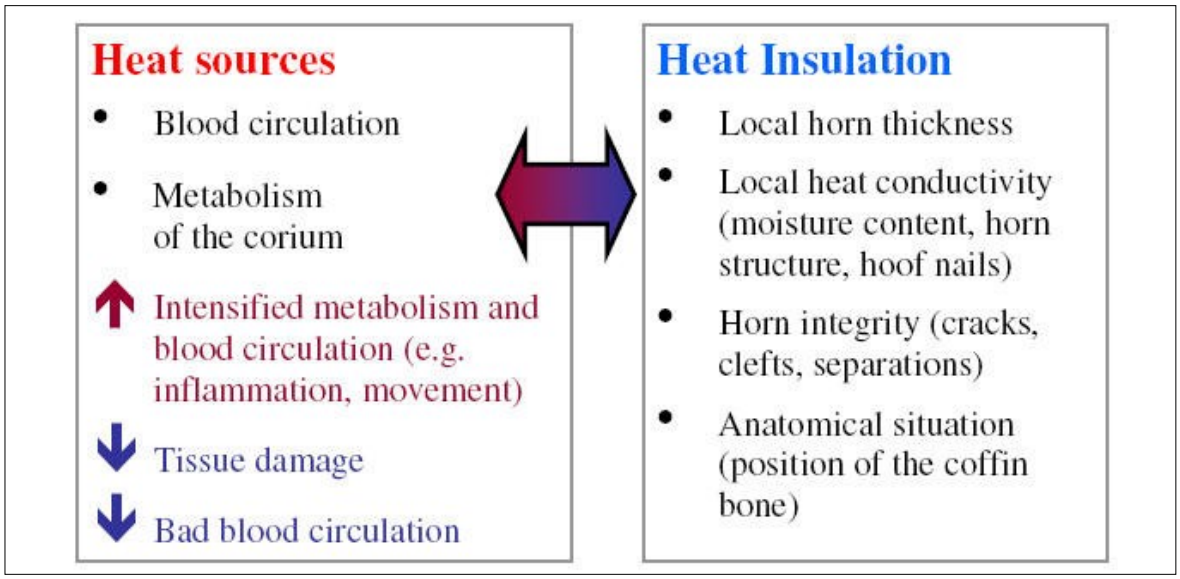


FIG. 3: INFLUENCE FACTORS ON THE SURFACE TEMPERATURE OF THE HOOF



With otherwise constant conditions for the heat loss (thermal conduction, convection, thermal radiation), the surface temperature of the hoof capsule is a result of the heat sources in the hoof and the insulation of the hoof capsule (Fig. 3).

Therefore, the temperature is highest in places of thin horn and high activity of the corium, thus at the coronet. Above the coronet, the insulation is usually higher as a result of the coat, which is giving an increased, uneven insulation, thus the measured temperature is lower.

Case example: Removal of horseshoes:

The following investigation was accomplished on a 3-year Oldenburger gelding shod on the front hooves. During the investigation period, the horse was in an ample box under relatively constant temperature conditions. The thermographic recordings were made before de-shoeing as well as after 2, 18 and 21 h.

At the represented front hooves, no further treatment took place, i.e. neither trimming nor correction, in the first 2 hours after the de-shoeing.

In each case, the temperature gradient was plotted along a line from the coronet down to the bottom edge of the hoof capsule with the software Thermacam Researcher. One line was positioned dorsal laterally at the position of the hoof nails, the other line dorsal in the center of the toe (Fig. 4 and Fig. 5).

The outside temperature of the hoof capsule decreases constantly from the coronet to the bottom edge.

- 2 hours after de-shoeing, the temperature had risen dorsal laterally at the coronet in relation to the shod condition by approx. 2°C and above the nail holes by approx. 5°C.

Heat sources
Blood circulation
Metabolism of the corium
Intensified metabolism and blood circulation (e.g. inflammation, movement)
Tissue damage
Bad blood circulation
Heat Insulation
Local horn thickness
Local heat conductivity (moisture content, horn structure, hoof nails)
Horn integrity (cracks, clefts, separations)
Anatomical situation (position of the coffin bone)
The horse was in a box with lack of movement.
- 21 hours after de-shoeing, the surface temperature was at the same level as 2 hours after de-shoeing.

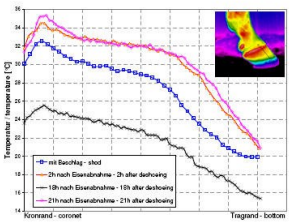


FIG.4: TEMPERATURE GRADIENT FROM CORONET TO THE BOTTOM HOOF EDGE AT THE HOOF NAILS

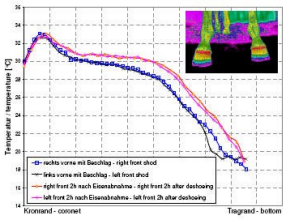


Fig. 5: Temperature gradient from coronet to the bottom hoof edge in the center of the toe

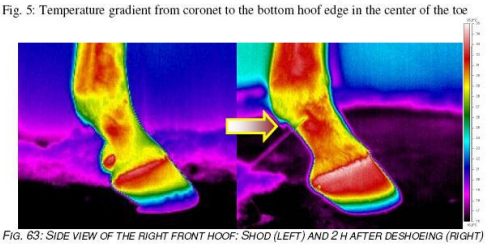


FIG. 63: SIDE VIEW OF THE RIGHT FRONT HOOF: SHOD (LEFT) AND 2 H AFTER DESHOEING (RIGHT)

At the coronet at the center of the toe, no temperature difference between the shod and unshod front hooves showed up 2 hours after de-shoeing. However, further down towards the bottom edge, the temperature increased by around 2-3°C.

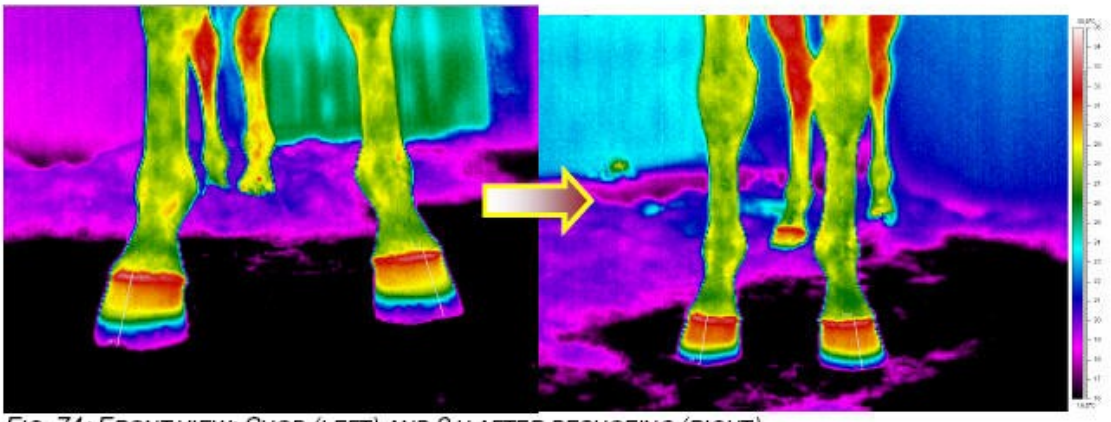


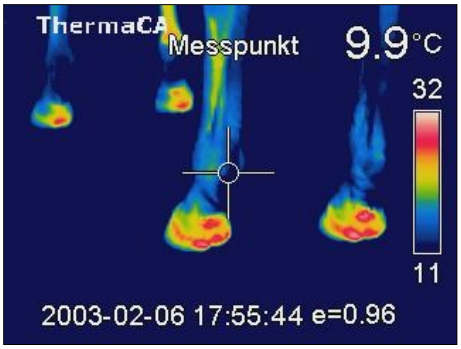
FIG. 74: FRONT VIEW: SHOD (LEFT) AND 2 H AFTER DESHOEING (RIGHT)

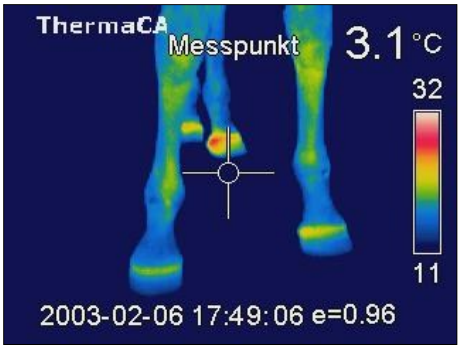
Summary

Within 2 hours, removing the shoes on the front hooves of a 3-year Oldenburger gelding led to a significant rise in surface temperature of the hoof capsule. The increase in temperature was highest at the lateral front, above the hoof nails with up to 5°C and smallest at the coronet. In the center of the toe, no temperature difference could be recognized at the coronet.
After spending the night in a box (18 h after de-shoeing), the temperature of the hoof was approx. 9°C lower, compared to the afternoon before and 3

hours later.

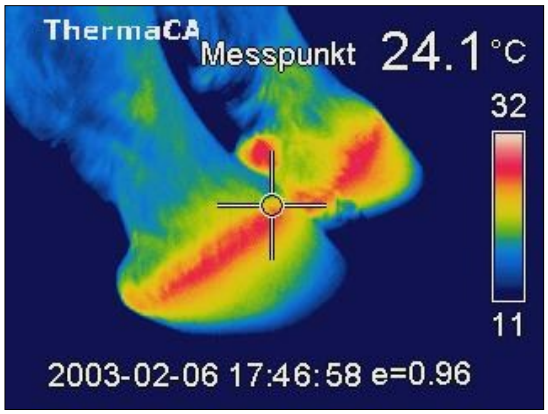
Following a case study with Thermography conducted by Sonja Appelt in Austria

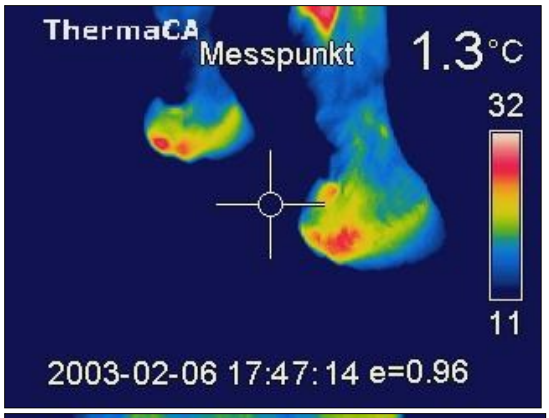


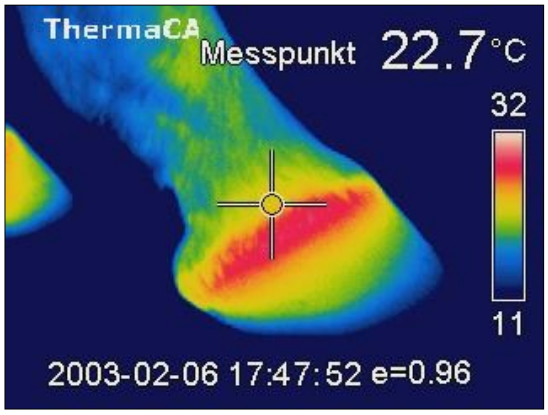


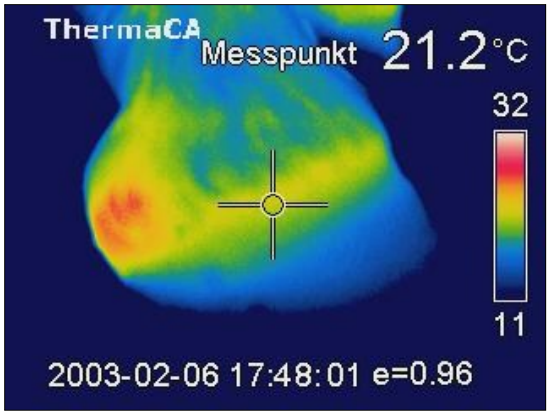
Thermography of 6y arab mare, changing lameness for more than 4 weeks, cannot stand still on concrete floor, bucked knees, tries to get weight off both front heels
Above: Comparison between fronts and hinds, seen from behind (blood flow through heels and bulbs)
Blood flow through bulbs is similar in fronts and hinds.
Hot area on right front leg is no inflammation but shaved hair that has been removed for ultrasonic examination)
Below: Comparison between fronts and hinds, seen from in front of the horse
Blood flow through toe and coronary is reduced in both fronts compared to hinds

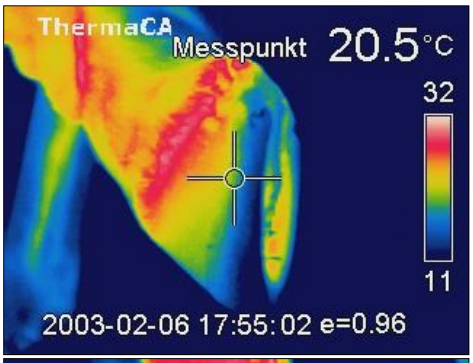
Lateral view of hinds (left) and fronts (right).
Blood flow through bulbs is similar while toe area is much cooler in fronts



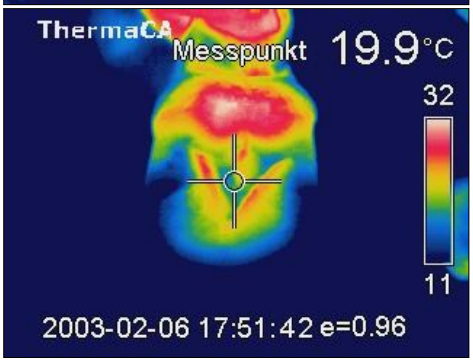








Above:
Left hind hoof: Good blood flow also in sole area
Below:
Left front hoof: Good blood flow in bulbs and bars, but reduced in sole



Pictures of the right front hoof:
Underslung heels, red white line that shows past inflammation.
Contracted, overlaid long bars up to tip of frog.

After my discussion with the veterinarian, he recommended to lower the heels which the farrier did and leave the horse barefoot.
According to the veterinarian, horse was much better after lowering the heels and moved more freely. (I was not present, would have been a good opportunity to check blood flow again.)
After 1 month the owner put shoes back on.
The images indicate clearly that in this horses front feet, the upper branch of the blood supply is open and blood flow to the bulbs and bars is o.k. while blood supply to toe area is reduced very much. This area is supplied by the main branch that is running through the navicular bone.
The images have been taken about 2 days after taking off the shoes. The reduction of blood flow is therefore not due to shoes but might be because of following reasons:

1. High heels:

According to Dr. Strasser the main branch through the navicular bone is pinched with steep alignment. This explanation fits exactly to the observation. According to her, lesions in the navicular bone that are observed on X-rays of navicular horses are caused by long time high heels -> pinching of artery after navicular bone -> increase of pressure in arteries -> increase of diameter -> loss of bone material around arteries.

2. Contraction:

Fronts are contracted very much, hoof mechanism is not working or even making the hoof more narrow, pushing the blood out of the toe.

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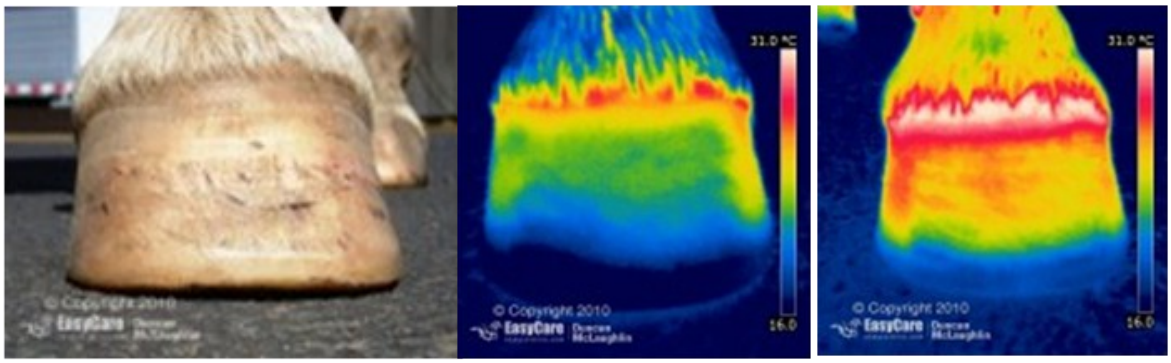
What Is Normal?

From the EasyCare Blog Site with Permission

Thermography provides you with a non-invasive, objective reading of the circulatory and inflammatory status of your horse by measuring heat. In conjunction with EasyCare, I am using thermographic techniques to investigate any differences in the heat distribution through the hoof and lower limb of horses using different hoof protection protocols (barefoot, booted and shod). As it will be a while before we finish collecting and collating that data, I thought you might be interested in viewing a few images in the interim.



Dorsal view of a near fore hoof belonging to a well performed barefoot endurance horse. The middle image is a thermograph of the hoof prior to a half hour of barefoot (unbooted), low-intensity exercise on a sand surface. The third image is a thermograph of the same hoof immediately on cessation of exercise.

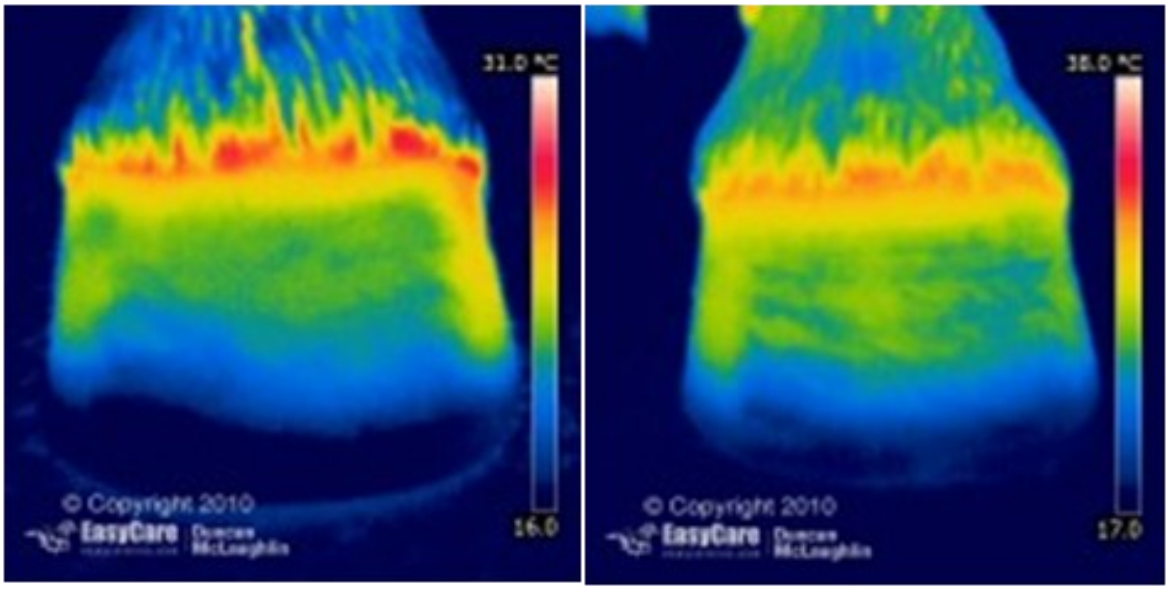
These images reflect what we generally find with all well-trimmed barefoot horses. If you examine the pre-exercise image in the middle, notice:

The band of heat (red and yellow) at the coronary band is thin and does not extend down the hoof;

There is a thin cold band (navy) at the bottom edge of the hoof where the wall contacts the ground; and

The majority of the hoof capsule is of moderate temperature (green and light blue).

Looking at the third, post-exercise image, we notice the entire hoof capsule has increased temperature. As the temperature scale for the two images is the same (16-31degrees C), the colors in the post-exercise hoof look 'hotter' but the heat pattern - thin band of heat at coronary band, thin band of cold near ground, majority of the hoof capsule warm – remains the same.

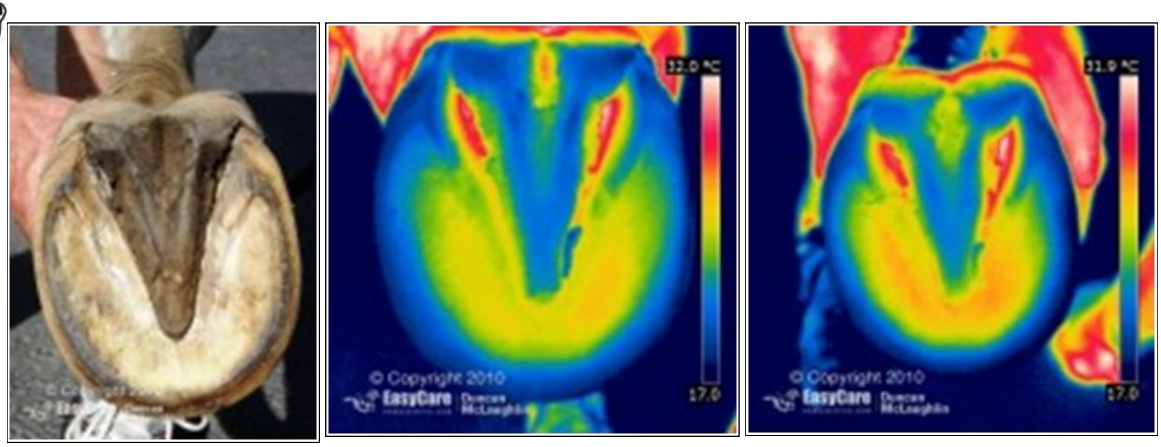


The same two thermographic images as before but with the temperature scale adjusted upward in the second, post-exercise thermograph, to compensate for the increase in temperature due to work. It is apparent just how similar the pre and post-exercise heat patterns are in a well trimmed barefoot horse.

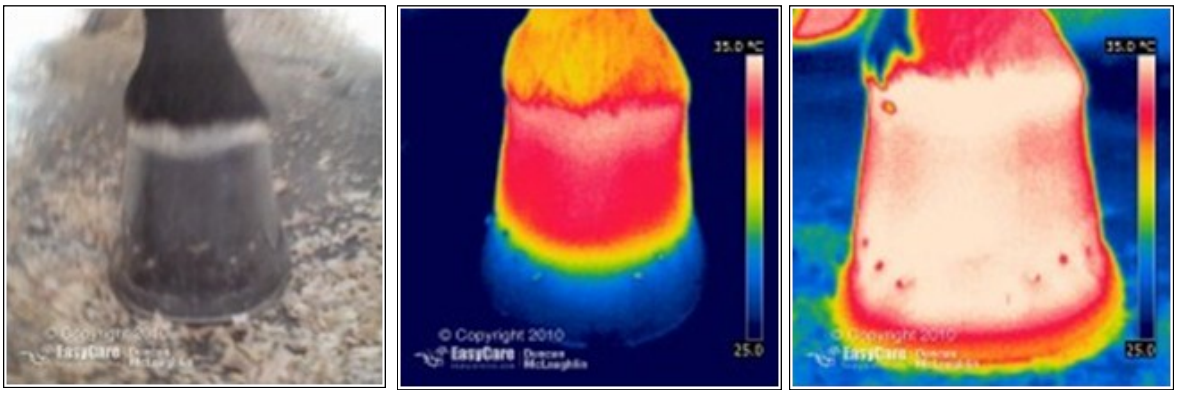
It is probably becoming obvious to you that although it is very difficult to directly compare the feet of different horses, doing different things, in different locations on different days, it is possible to determine statistical trends in both

changes in actual temperature; and

changes in temperature patterns (or not) across the hoof.



Solar view of the same hoof with pre and post-exercise thermographs. Just for your interest, note that the collateral sulci by the frog (white and red), along with the coronary bands, and the skin around the eyes, nose and anus are always the hottest areas detected: this is not inflammation at the sulci and does not indicate impacted bars or other such nonsense.



Dorsal view of a near fore hoof belonging to a shod western pleasure show horse. The middle image is a thermograph of the hoof prior to an half hour of low-intensity exercise on a sand surface. The third image is a thermo-graph of the same hoof immediately on cessation of exercise.

As noted, it is not possible to directly compare the thermographs of different horses in different location on different days. For example, the temperature scale here (25-35degrees C) is different to the barefoot horse at top (16-31degrees C). However, it is possible to compare patterns of heat across the hoof and changes to those heat patterns with work.

This shod hoof shows an extended hoof capsule, at least by barefoot stand-ards and by the standards of shod horses competing in more athletic events (3-day eventing, endurance riding, etc), though not by show horse stand-ards. Both the farrier and the trainer of this horse considered this a well-shod hoof. Looking at the middle, pre-exercise thermograph, notice:

The band of heat (pink and red) at the coronary band extends down to encompass well over half the hoof capsule;

There is a thick cold band (blue) from the bottom edge of the hoof, extending up and over the level of the nail clenches;

The band of warm hoof (yellow and green) is very thin, merely a transition zone between the hot hoof above and the cold hoof below; and

The nails are conducting heat. Where the nail clenches are in the cold (blue) portion of the foot they are warmer (green dots), where they are in the warm (green) portion of the foot they are colder (blue).

Although you may consider this a more extreme example, this is the heat pattern we observe in the majority of shod horses.

Looking at the third, post-exercise image, we notice the entire hoof capsule has not only increased temperature but the heat pattern has also changed radically: the entire hoof has become as hot as the coronary band (usually the coronary band is one of the hottest areas detected by thermography and much warmer than other hoof components). As you can see, no amount of image manipulation or temperature scale adjustment will produce a post-exercise image similar to the pre-exercise one.