

# A Preliminary Study Using Infrared Thermography



**To Investigate Temperature and Heat Patterns  
In The Feet of Horses Using Different Types of  
Hoof Protection At Endurance Rides**

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by Duncan McLaughlin and EasyCare Inc.



# A Preliminary Study Using Infrared Thermography

to Investigate Temperature and Heat Patterns In The Feet of Horses  
Using Different Types of Hoof Protection At Endurance Rides

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**H**orses competing in endurance rides and using different types of hoof protection demonstrate marked differences in the degree of hoof temperature increase during the ride. Horses competing with shoes had an average dorsal hoof-wall increase of 8.9°C /16.1°F when comparing their pre-ride and post-ride temperatures. By comparison, the average dorsal hoof-wall increase was 2.9°C/5.2°F for horses wearing hoof-boots. Similar differences were found in the average temperature increases at the coronet (6.7°C/12.1°F for shod horses, 2.2°C/3.9°F for booted horses) and at the distal toe wall (9.6°C/17.3°F for shod horses, 3.2°C/5.8°F for booted horses). The pattern of heat across the dorsal wall surface also differed markedly for shod and booted horses.

## Why This Study?

Most owners and riders of barefoot horses, using hoof-boots where necessary, are already aware of the many advantages arising from natural hoof care, including ease of management, cost savings, hoof health and horse performance. Yet barefoot performance horses remain a minority across most equine competition. Although some owners and riders of shod horses object to natural hoof-care on philosophical and/or practical grounds, the primary reason most say they continue to shoe is: "the horse is doing just fine thanks." But even if they are clearing a show-jump round, executing a spectacular sliding stop, or trotting 'sound' at the end of a 160km endurance ride, are those shod horses actually doing just fine? 'Just fine' is a subjective assessment.

Infrared thermography is a tool that provides objective data about circulation and inflammation in the hoof by measuring heat. Examining actual temperature increases and changing heat patterns enables a non-subjective comparison of the actual hoof status for horses competing with different types of hoof protection.

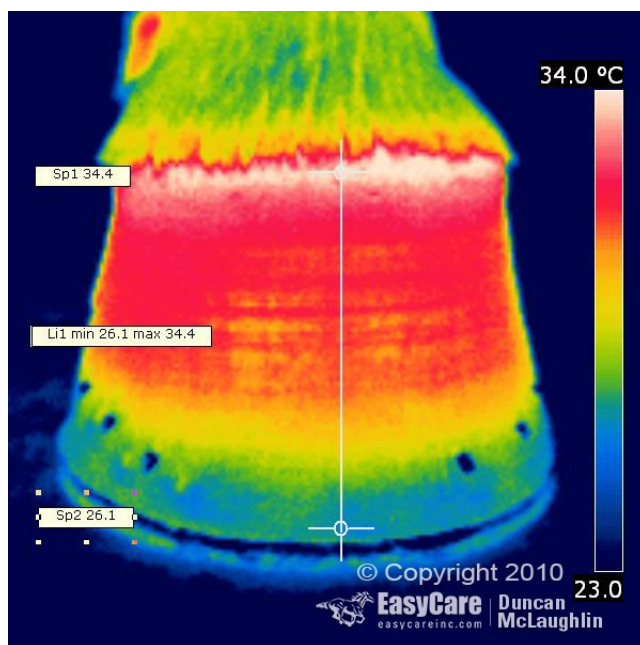
## The Protocol

Thermographic and photographic images were taken of the feet of endurance horses competing at five different endurance rides (80-160km/50-100 miles) in two countries. The pre-ride images were captured the day before the ride and the post-ride images were taken immediately after the final vetting (between 25 and 45 minutes after completing the ride course). Both pre-ride and post-ride images of horses using hoof boots were taken with the boot removed.

Although an extensive range of images were captured, for this study dorsal (front-on) images of the near-fore hoof were analyzed. For each image a line was imposed down the hoof wall, from the coronary band to just above the distal toe. Three measurements were obtained:

1. temperature at the point just above the distal toe at the bottom of the line
2. temperature at the point on the coronary band at the top of the line
3. average temperature along the line.

## Image 1



*Values were obtained by imposing a line down the dorsal hoof wall surface. In most, but not all, cases, the highest temperature on the line is recorded at the coronet and the lowest at the distal toe. When this was not the case, the highest temperature was very close to the coronet and the lowest very close to the distal toe.*

Not all images were used. Poor quality images and images with thermographic artifacts are not reliable and were discarded. There was a large range in the hoof capsule form and length amongst the shod horses competing at endurance rides. Images from those shod horses with severe imbalance or extremely long hoof capsules were analyzed but were not included in the study so as not to bias the results, although those horses were still out competing 'just fine'. Interestingly, the booted horses all showed very similar form: short hoof capsule, little or no dorsal wall concavity and obvious solar concavity.

### Results – Hoof Temperature

There were marked differences in the degree of hoof temperature increases during the ride when comparing booted and shod horses.

Data on hoof protection type and temperature values obtained from thermographic images is presented in the Table 1a. The means and standard deviations for the different areas of interest are presented in Table 1.

**Table 1: Combined Mean Data**

	Overall Mean	Overall St Dev	Booted Mean	Booted St Dev	Shod Mean	Shod St Dev
Preride Distal Toe	18.3	4.6	20.7	3.7	16.0	4.4
Preride Coronet	27.7	4.9	29.2	2.4	26.1	6.4
Preride Dorsal Wall	23.1	4.1	24.6	2.8	21.5	4.7
Postride Distal Toe	24.7	3.1	23.9	2.4	25.6	3.6
Postride Coronet	32.1	2.5	31.4	1.9	32.8	2.9
Postride Dorsal Wall	29.0	3.3	27.6	2.8	30.4	3.3
Difference Distal Toe	6.39	4.58	3.2	1.8	9.6	4.3
Difference Coronet	4.46	4.02	2.2	0.8	6.7	4.8
Difference Dorsal Wall	5.94	4.07	2.9	0.9	8.9	3.7

### Take-home message for hoof temperature increase

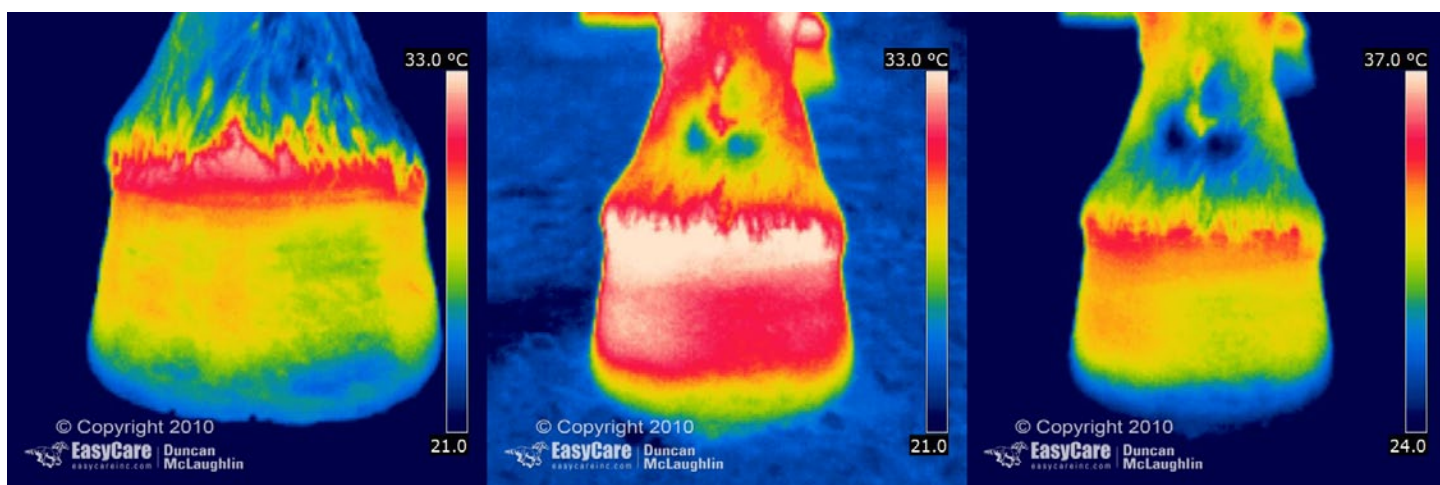
1. The increase in the temperature at the distal toe was 3.2°C/5.8°F (N=9, StDev=1.8°C/3.2°F) for horses wearing hoof-boots compared to 9.6°C/17.3°F (N=9, StDev=4.3°C/7.8°F) for horses wearing shoes.
2. The increase in the temperature at the coronet was 2.2°C/3.9°F (N=9, StDev=0.8°C/1.4°F) for horses wearing hoof-boots compared to 6.7°C/12.1°F (N=9, StDev=4.8°C/8.6°F) for horses wearing shoes.
3. The increase in average dorsal hoof wall temperature was 2.9°C/5.2°F (N=9, StDev=0.9°C/1.6°F) for horses wearing hoof-boots compared to 8.9°C/16.1°F (N=9, StDev=3.7°C/6.7°F) for horses wearing shoes.

Note: The coronet band was usually but not universally the hottest point on the dorsal wall. The distal toe was usually but not universally the coldest point on the dorsal wall. This is true pre and post-ride in both booted and shod horses

## Results – Hoof Heat Pattern

The pattern of heat across the dorsal wall surface also differed markedly between booted and shod horses. Booted horses consistently showed a pre-ride temperature pattern of three horizontal bands across the hoof wall: A thin, hot band along the coronet; a thin, cold band along the distal toe; these separated by a very thick, warm intermediary band. This pattern was the same post-ride, with the actual temperatures in each band simply increasing a few degrees.

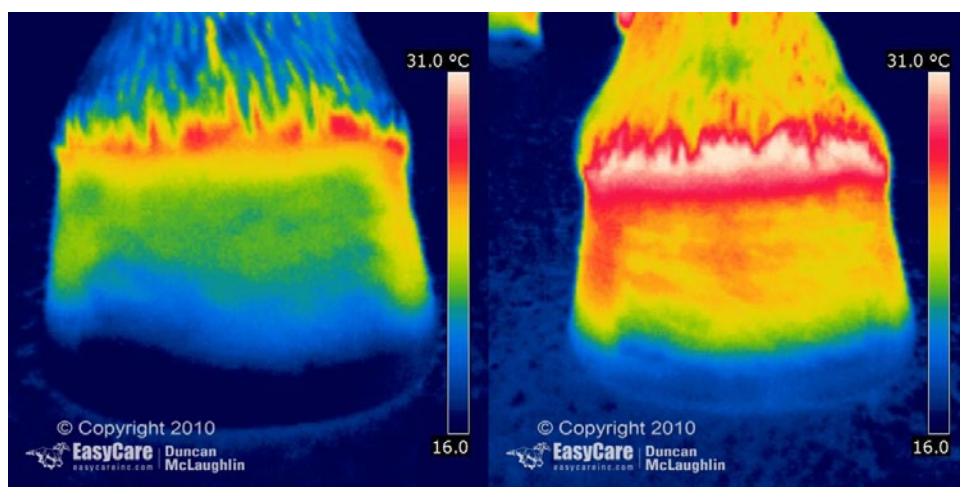
### Image 2



*Pre and post-ride thermographs of horse competing in an 80km/50mile ride in hoof-boots (boots removed for the thermograph). The first image is the pre-ride image. The second and third images are the same, post-ride, image but with different temperature scales. In the middle image the temperature scale is the same as the pre-ride image, demonstrating the increase in heat from the ride. In the image on the right, the temperature scale has been adjusted upward and demonstrates the heat pattern pre and post-ride remains the same.*

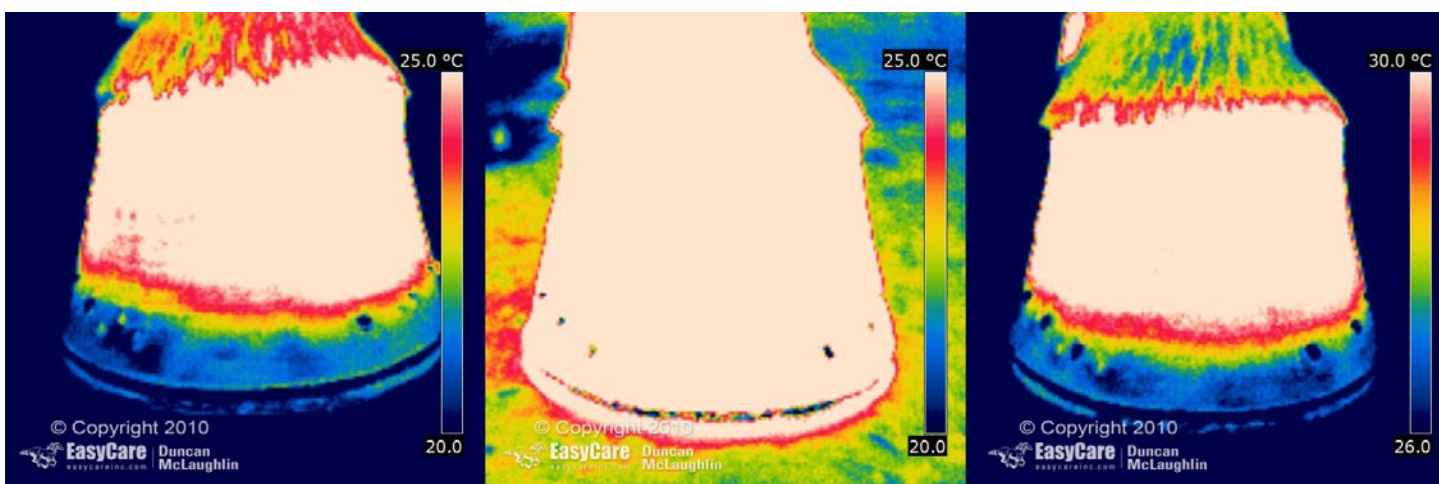
The pre and post-ride heat pattern found in booted horses is the same as found in exercising (un-booted) barefoot horses. Image 3 shows thermographs, from the same horse used in Image 2, before and after a half hour of low intensity barefoot exercise on sand. This indicates that booted hooves show similar function to barefoot hooves.

## Image 3



*Pre and post-exercise thermographs of a barefoot horse (un-booted) performing a half hour of low intensity exercise on sand.*

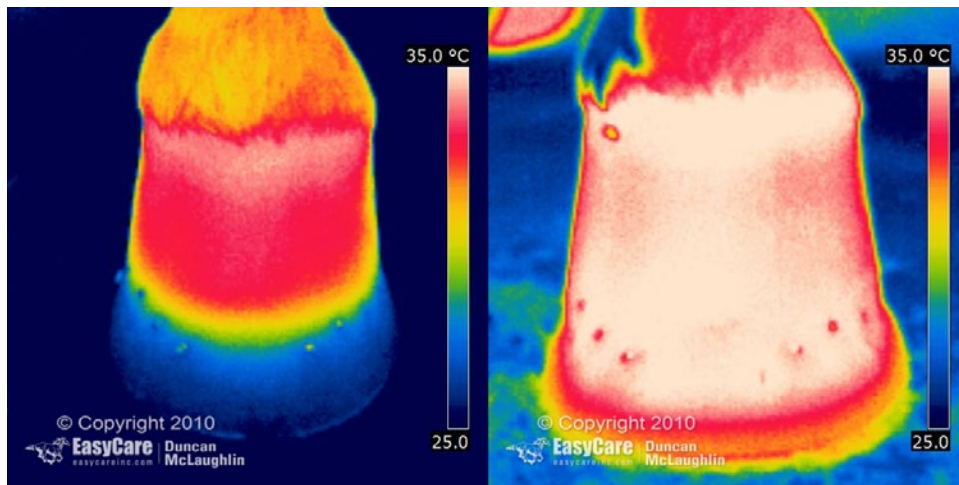
## Image 4



*Pre and post-ride thermographs of horse competing in an 80km/50mile ride with metal horse shoes and, for a shod horse, a relatively short hoof capsule. The first image is the pre-ride image. The second and third images are the same, post-ride, image but with different temperature scale. In the middle image the temperature scale is the same as the pre-ride image; it appears that the entire hoof capsule has a uniform heat pattern. However, in the instance of this short-toed shod horse it actually only reflects the large increase in temperature over the whole hoof. When the temperature scale is adjust upward, as in the image on the right, the heat pattern remains the same as the pre-ride image.*

Image 4 shows a horse one of the best shod horses in the study. The trend toward a uniformly hot hoof capsule appeared to be aligned with increasing hoof capsule length. Shod horses with relatively short hoof-capsules showed less change, where those with longer hoof capsules tended toward the uniformly hot pattern.

## Image 5



*Pre and post-exercise thermographs of a shod horse with excessive hoof capsule length performing a half hour of exercise on sand.*

Image 5 shows an extreme version of the universally hot post-work hoof capsule. This is not a horse from the study – it is a show horse with an excessive hoof capsule – and is used here to demonstrate the end point of heat pattern change in shod horses.

### Take-Home Message for Heat Patterns in Hoofs

1. Pre-ride heat patterns of barefoot/booted horses are consistently different to shod horses. Barefoot/booted horses demonstrate three horizontal bands across the hoof wall: a thin band of heat at the coronet, a thin band of cold at the distal perimeter of the hoof, with the large majority of the hoof capsule within a warm intermediary band. Shod horses also have a three band pattern but the hot top band extends down for a significant proportion of the hoof capsule. The intermediary warm band is thin and the cold bottom band is of varying thickness that, anecdotally, appears to depend on hoof capsule length.
2. Post-ride, booted horses demonstrate the same three band pattern as pre-ride but with the temperatures of each band increased by a few degrees. Shod horses varied in their post-ride pattern: some showed little pattern change (although this is masked by the large actual temperature increases over the hoof), whereas others moved toward a universal hot hoof capsule. Anecdotally, the change appears to be aligned with hoof capsule length.

## Points for Consideration

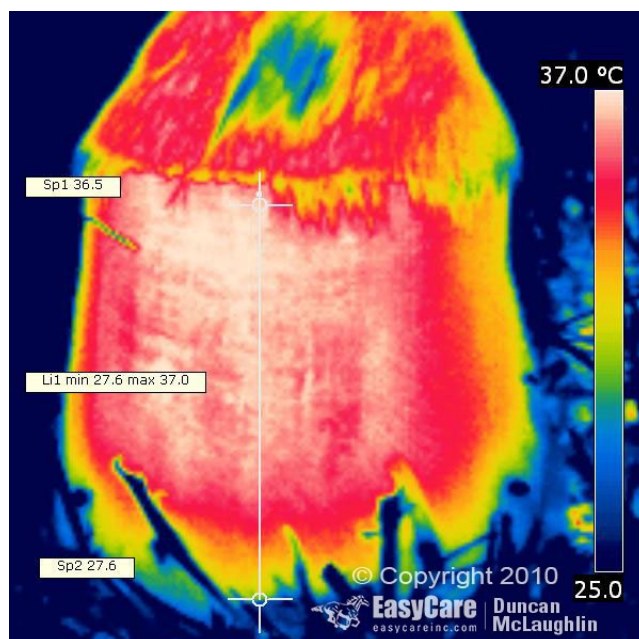
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The results from this study suggest that the lamellae serve as an important source of energy dissipation in the hoof. Lamellae not under stress from peripheral loading are better able to dissipate energy. Endurance horses competing in boots appear to have the same heat patterns and smaller temperature increases as barefoot horses working under less strenuous conditions.

By contrast, shod horses are less able to dissipate energy, leading to significantly higher increases in hoof-wall temperature during endurance rides. Watching shod endurance horses in the four to eight hours following a 160km/100mile ride, alternatively shifting weight from one foot to the other, suggests an inflammatory response. It is not possible to determine if the increased temperature found in this study is due to a simple lack of energy dissipation or due to inflammation but this could easily be determined in future investigations. Simply do several post-ride follow-up thermographs every few hours: if the post-ride temperatures of the feet of shod horses eventually come down to levels similar to those of booted horses we can suspect merely compromised lamellae function. If they remain significantly hotter, we can suspect some form of inflammation (road founder).



## Image 6



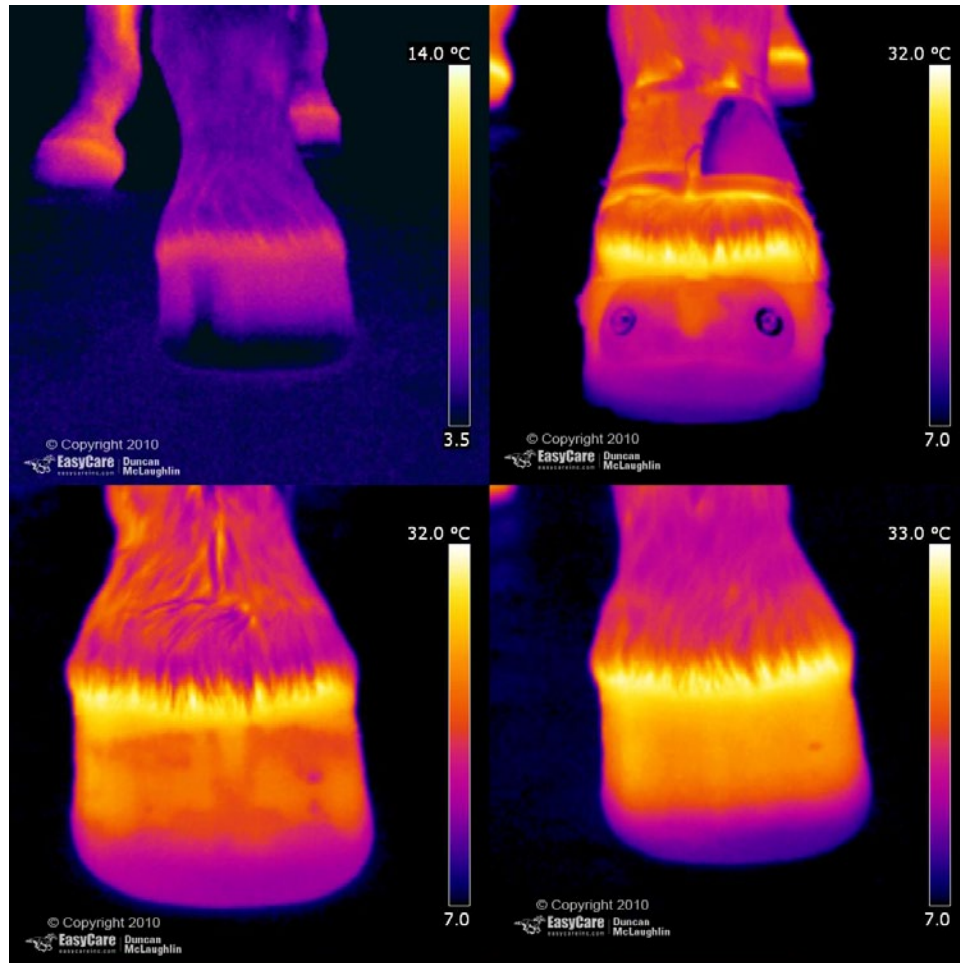
*Post-ride image of a horse wearing non-metal shoe demonstrates the same large temperature increase and thermal pattern as metal-shod horses.*

Only two horses in the study wore non-metal (i.e., plastic/urethane) shoes. These horses did not differ from horses shod with metal shoes with regard to either temperature increase or post-ride heat pattern. This suggests it is the biomechanics of the shoe (peripheral loading) and/or trimming to apply shoes (digital descent), rather than the material the shoe is made of that is responsible for the difference in temperature increases and heat patterns between shod and booted horses.

Placing a shoe on a hoof, peripheral loading, places the lamellae under strain they are unable to cope with. Inevitably there is some degree of digital descent as the hoof wall is pushed up around the skeletal axis with increasing workloads. The resulting lowered position of the coffin bone within the hoof capsule disables the farrier from shortening the toe sufficiently at the next trim – increasingly longer hoof capsules result. The booted horses in this study were observed to have universally short hoof capsules, generous solar concavity and very often the wall was, to varying degrees, somewhat or completely passive when standing on a hard flat surface – indicating the coffin bone is sitting high and forward in the hoof capsule. They also appeared to have thick walls and very tight white-line connections.

As noted, personal observation suggests that shod horses with longer hoof capsules appeared to have more extreme heat patterns than shod horses with relatively short hoof capsules. It is not possible to determine from this study whether it is increased digital descent of the coffin bone or more extreme peripheral loading due to increased amount of hoof wall past the solar periphery (or a combination of both) that is responsible for the more extreme temperature increase and pattern changes in longer hoofed horses. It may be possible to get a clearer understanding in future investigations simply by recording the dorsal wall length and estimating the amount of wall below the sole on which the shoe is seated and then incorporating these measurements into the analysis.

## Image 7



*Thermographs of the near-fore hoof of a horse doing a three hour trail ride in cold weather. Clockwise from top left: 1. Pre-ride un-booted. 2. Post-ride with boot still on. The boot is cooler than the hoof. The two dark circles are the metal studs for a power strap, which are transferring more heat to the air than the rest of the boot (metal is an efficient conductor of energy). 3. Post-ride un-booted hoof, immediately on taking the boot off. It is obvious the boot has been acting as a heat sink – you can clearly see the outline and cooler hoof temperature under the boot still showing on the hoof. 4. Post-ride un-booted, twenty minutes after taking off the boot.*

Lastly, there is speculation that partly encasing the hoof capsule in non-breathable boot may affect hoof temperature and even that the color of the boot may play a significant role in hoof temperature. I have not yet recorded a post-ride thermographic image where the hoof-boot was warmer than the hoof it encased - this includes endurance horses competing in 80km/50mile rides during summer. Certainly in cold weather, the boot temperature is closer to the ambient temperature and always acts as a heat sink for the hoof.

## Conclusion

The results from this study support the argument by natural hoofcare proponents that shoeing compromises hoof form and function. Shod horses that appear to be managing 'just fine', or even turning winning performance, are experiencing significantly greater temperature increases and changes in heat patterns across the hoof during endurance competition when compared to their booted counterparts. By comparison, the temperature increases and heat patterns in booted horses appear the same as unbooted barefoot horses performing less exercise, suggesting natural energy dissipation mechanisms are maintained.

Duncan McLaughlin is a professional hoof care practitioner and horse massage therapist. He began natural hoof trimming in 2001, just when barefooting was just taking off in Australia. He likes to combine his barefoot trimming with his experiences as a rider and as a horse massage therapist (Certified IV Equine Myofunctional Therapy). He has trained and competed in a range of horse activities but predominately dressage and endurance riding, including Tevis, Shahzada and Quilty.

Duncan works with veterinarians and other horse health professionals to create positive outcomes for horses experiencing serious hoof pathologies. He has successfully rehabilitated unrideable foundered and navicular horses back to riding soundness.



EasyCare Vision:

We will be the global innovator in hoof care solutions that enhance the horse/human relationship.

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## Appendix 1: Raw Data

Horse Information					Temperature Measurements						Pre/Post Ride Differences		
Horse No.	Hoof Protection	Hoof Protection Subtype	Pads/Sole Pack	Hoof	Pre-ride Distal Toe	Pre-ride Coronet	Pre-ride Dorsal Wall	Post-ride Distal Toe	Post-ride Coronet	Post-ride Dorsal Wall	Difference Distal Toe	Difference Coronet	Difference Dorsal Wall
1	B	EBG	N	NF	24.8	32.2	27.8	26.4	33.1	30.4	1.6	0.9	2.6
4	B	EBG	N	NF	24.6	32	27.8	26.6	33.2	30.8	2	1.2	3
10	B	EBG	N	NF	19.8	28.9	23.1	24.4	31.4	27.3	4.6	2.5	4.2
12	B	EBG	N	NF	24.6	30	26.3	26.7	32.2	28.8	2.1	2.2	2.5
14	B	EBG	N	NF	23.7	29.2	26	24.1	32.4	30.2	0.4	3.2	4.2
16	B	EBG	Y	NF	16	24.1	18.9	20.7	26.8	22	4.7	2.7	3.1
13	B	EBGO	Y	NF	17.2	28.4	23.1	23	31.7	26.5	5.8	3.3	3.4
15	B	EBGO	Y	NF	18.2	29.6	24.2	21.6	31.3	25.4	3.4	1.7	1.2
17	B	EBGO	Y	NF	17.3	28.3	24.5	21.3	30.8	26.8	4	2.5	2.3
3	S	SMR	N	NF	20.1	31.8	25.5	26.1	34.4	30.3	6	2.6	4.8
5	S	SMR	N	NF	15.9	29	23.3	23.5	31.7	29.7	7.6	2.7	6.4
7	S	SMR	N	NF	14	22.1	18.7	21.1	30.3	26.5	7.1	8.2	7.8
8	S	SMR	N	NF	11.7	13.7	13.9	18.8	28	24.7	7.1	14.3	10.8
9	S	SMR	N	NF	12.3	20.4	16.9	27.2	34.3	33.2	14.9	13.9	16.3
18	S	SMR	N	NF	10	24.7	17.7	27.7	30.8	29.9	17.7	6.1	12.2
2	S	SMR	Y	NF	23.3	31.5	27.1	29	34.6	32.2	5.7	3.1	5.1
6	S	SPNO	N	NF	19.3	30.2	25.5	27.6	37.5	35.5	8.3	7.3	10
11	S	SPNO	N	NF	17.1	31.8	24.6	29.1	33.7	31.7	12	1.9	7.1

### Key:

#### Hoof Protection:

B = Boot  
S = Shoe

#### Hoof Protection Subtype

EBG = Easyboot Glove Hoof Boot  
EBGO = Easyboot Glue-On Hoof Boot  
SMR = Metal Rim Shoe  
SPNO = Plastic Nail On Shoe

#### Hoof

NF = Near Fore

#### Pad/Sole Pack

Y = Yes  
N = No