The Effects of Long Term Positive Frog Loading on the Distance between the Heels of the Foot

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Introduction

Contracted feet and contracted heels are terms which are often used to describe the same thing. Contracted feet are often poorly defined if at all and there is very little written about them apart from a few small chapters in some farriery text books (Shoeing for Performance 1989, Hickman's Farriery 1977). Although symmetry of function and appearance of the horse may be desirable, it is seldom the case (Gray, 1989). Feet which have considerable asymmetry are considered aesthetically less desirable and functionally compromised.

One definition of a contracted foot (or hoof) is described as a condition where the posterior half of the hoof undergoes a significant reduction in width (Curtis 2002). Other notable changes are that the walls (of the foot) become more upright, making them less efficient in absorbing shock during locomotion (Colles and Ware 2010).

These definitions suggest that the affected foot or hoof changes over a period of time and takes on a new appearance or shape from that of its origin (Figure 1). It is widely agreed that ideally, both front feet should be identical in size and shape, or nearly so, and any asymmetry should be noted (Ross and Dyson 2011).

Figure 1*: A contracted foot in that the posterior half of the foot has undergone a significant reduction in width.*

The causes of these physical changes in contracted feet are thought to be numerous and varied. Primary causes can range from lameness and/or disease of the affected foot, which leads to a prolonged period of contralateral weight-bearing on the affected limb. This leads to a lack of normal function and ultimately contraction in the bulb of heel and frog area. Often, these feet have atrophied frogs which impacts upon the physical appearance and function in the caudal area of the foot.

There are no specific techniques used to diagnose contracted feet such as the observation of radiographical changes etc. Diagnosis of this condition is essentially by observation of the foot (Colles and Ware 2010) and clinical signs.

The consequences of such changes not only affect the appearance of the foot (Figure 2) but can impact on the athletic ability of the horse and also on the horse's soundness. It has historically been observed that contracted feet expand to a much less extent than normal feet (Dollar and Wheatley 1897). It is also considered undesirable by most horse owners to have a horse with one asymmetric or contracted foot. Horses with notable asymmetry are less likely to do well in showing classes or other competitions where appearance is a consideration.

Figure 2: *Asymmetric feet. The left-fore being more sloping than the right- fore.*

Although it is important for farriers and vets to recognise contracted feet, it must be remembered that conformation is individual to each animal and there are many horses, often within the same breed, which have a more naturally occurring narrower foot conformation. Therefore a narrow foot is not necessarily a contracted foot (Stashak, 1996) and these should not be confused with feet which have contracted from their original size.

There have been many studies carried out researching and measuring frog pressure (Colles 1989, Roepstorff 2001) and its relationship with heel movement (expansion and contraction) during locomotion. There has been much conjecture as to how much influence the frog has upon expansion and contraction of the heels during locomotion. It has been observed that expansion of the heels of the foot are not controlled purely by pressure from the frog (Colles, 1989), although he did note that this was an important factor. Other authors agree with this saying that frog pressure does not appear to play a part in hoof expansion (Parks, 2002).

A study by Roepstorff et al (2001) however, completed an in vivo, in vitro study into heel expansion in relation to shoeing and frog pressure. They observed that the average heel expansion was significantly increased when pressure was put on the frog, and significantly lower when pressure to the frog was alleviated. They did however conclude that some heel expansion still occurred when the frog and sole were unsupported. The effects of this were not measured over a prolonged period of time though, including when the horse is at rest.

Although there has been little documented research in this area, it is widely believed that the effects of contraction are irreversible. Others however believe that it is possible to increase the distance between the heels in contracted feet and ultimately de-contract the foot by shortening the toes and allowing the frog to bear weight (Smith, 2013).

To date, there are no published studies examining the effects of loading the frog over a prolonged period of time and the effects this has on the distance between the heels of the foot.

The aim of this study is to ascertain whether long term positive loading to the frog has any influence or bearing on the distance between the heels of the foot.

Materials and Method

A sample of five horses was selected according to their suitability, location and conformation. The sample reflected the general population of horses in that there were a mixture of breeds and sizes and some of the horses had contracted feet and some did not. Unfortunately, one of the horses died approximately four months into the study. A replacement horse was not sourced and so this brought the study population down to four horses.

One of the horses (Horse C) had two contracted feet before the commencement of the study. The right-forefoot was considerably more contracted than the left-fore and the owner informed me that these had developed over a period of years through unknown reasons.

Figure 3: *Contraction has occurred in the left fore -foot (Horse C).*

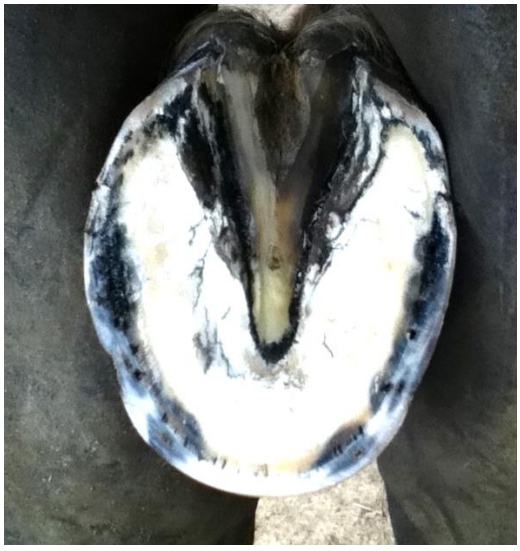

Figure 4: *The right foot is considerably narrower than the left, particularly in the heel area (Horse C).*

Horses A and B had definite asymmetry in their front feet prior to the commencement of the study but only horse A's left-fore could be considered contracted. The contraction was

unilateral in that it was only evident on the medial heel. Horse D's feet were what can be defined as a matching pair in that they were the same size and angle. Table 1 shows brief details of each horse included in the study. In-depth details of all horses can be found in appendices 1 to 4.

Table 1: Key Details of Study Horses

Horse	Age	Breed	Height	Approx. Weight	Work	Foot Conformation
A	12	Irish Draught	16.2hh	532kg	Light hacking	Upright/asymmetric L/F contracted medial heel Atrophied frogs
B	18	Cleveland Bay	16.2hh	540kg	Light hacking	Asymmetric feet L/F smaller, upright R/F bigger, sloping Strong frogs
C	19	Welsh Section D Cross Dales	14.1hh	414kg	Regular hacking, competing, riding club	Asymmetric feet Both contracted L/F contracted R/F very contracted Atrophied frogs
D	15	Belgian Warmblood	15.1hh	504kg	Weekend hacking	Feet symmetrical Same size Weak walled (medial) Strong frogs

Inclusion Criteria

A high priority was given to the horses' locations prior to the commencement of the study. All of the horses were within a 5 mile radius of the author's forge to facilitate a rapid response if shoes were lost or any other problems developed. They were all healthy, living out in the field and were used for general purpose riding activities including hacking and low level competing. One of the horses (Horse C) was used more than the other 3, hacking and competing regularly throughout the course of the study. Horses A, B and D were used less regularly, hacking occasionally at weekends and owners' days off. All of the horses were mature and all between the ages of 11 and 19 years old.

Another important criteria for inclusion were the owners. It was felt that the owners had to be receptive to the research and willing to provide their horses. All the owners were fully briefed about the details and potential implications of the research. They were also informed that if at any time throughout the study they wished to withdraw their participation then this was their absolute right. It was made clear that their horse's welfare and well-being were primary considerations at all times and that their horse would not be caused any intentional discomfort. Financial incentives were offered to each owner regarding the farriery costs for the duration of the study. Owner consent forms are attached at appendix 5.

Outline

Each horse was shod a total of ten times over the course of the study and the study involved front feet only. Each horse was shod using Blurton heart-bar shoes with no clips to rule out any influence on expansion of the foot or alteration to foot shape (Figure 5). One of the horses (Horse B) was shod with a combination of Cottam heart-bar shoes and Blurton heart-bar shoes, this was originally down to availability from suppliers. All the horses were shod by the author in open heeled shoes prior to the commencement of the study.

Figure 5: *Each horse was shod using Blurton heart-bar shoes with no clips.*

Trimming and Measurement Protocol

The protocol for each shoeing was strictly adhered to and involved the same people performing the same tasks each time the horses were shod. The horses would be shod one foot at a time to allow for accurate measurements and statistics to be recorded and also to limit variables like feet “relaxing” whilst no shoe was present and to limit the effects of any foot scraping. The shoeing protocol was as follows:

1. Left/Near fore shoe taken off
2. Foot brushed out and totally cleaned ready for the application of the label
3. Label and heel dots applied

Each foot was labelled with a Wilko self-adhesive white label measuring 53mm across. The measurement of the label was crucial to the programme Metron™ which was used to calibrate and record the measurements. Recorded on each label was the horse’s name, which foot it was and whether it was pre or post trimming. White dots were applied on the point of heel of the untrimmed feet. The reason for this was that it was discovered in the pilot study that the exact point of the heel was difficult to define on some of the pictures. The dots were applied with an Artline EK-400XF Paint Marker (white). Figure 6 shows the pre-dressed foot, labelled, including white dots and ready for calibration into Metron™.

Figure 6: Pre-dressed foot with label applied ready for a photograph to be taken in order to calibrate the required measurements.

4. Three photographs were taken of the solar aspect of each foot to ensure that a suitable quality picture could be used to ascertain accurate measurements. The pictures were taken using an Olympus D-745 14 Mega Pixel Digital Camera.

5. The height of each heel was recorded manually by Halfords Advanced Professional Digital Vernier Calipers (Figure 7). The reason for this is that the Metron-Hoof ™ computer program used for measuring the photographs could not decipher the heel height measurements.

Figure 7: *Heel height measurements were taken manually using the professional Vernier digital calipers.*

All measurements were recorded on the Thesis Statistics Gathering Form which can be found at Appendix 6. The following information was recorded onto each form:

a. Total width of the foot (widest part to widest part)

b. Inside point of heel of the foot to the centre of the toe

c. Outside point of heel of the foot to the centre of the toe

d. Heel distance (distance between the two points of heel)

e. Circumference of the foot (from the inside point of heel, all the way around the circumference of the outer weight-bearing part of the hoof wall to the outside point of heel

f. Height of the inside (medial) heel

g. Height of the outside (lateral) heel

Measurements calculating the inside point of heel to the toe and outside point of heel to toe were taken for completion.

6. The foot was then dressed in anticipation of the heart-bar shoe being fitted.

Feet were dressed in the medial/lateral plane in accordance with the T-square in order to limit variables and standardise the medial/lateral balance (Figure 8).

Anterior/posterior dressing was done in accordance with the hoof pastern axis. The frog was largely left alone to optimise function with only small flaps being removed and tidied.

Figure 8: *All feet were dressed medio-laterally in accordance with the T-square to limit variables and maintain standardisation.*

7. A second label was then applied to allow measurements to be taken of the post-dressed foot.

8. A second set of three photographs was then taken of the solar aspect of each foot, again, to ensure that a suitable quality picture could be used to ascertain accurate measurements (Figure 9).

Figure 9: *A second photograph was then taken, this time of the post-dressed foot.*

9. The height of each heel was again recorded manually by Halfords Advanced Professional Digital Vernier Calipers.

Shoeing Protocol

The very first shoeing of each horse was aimed at establishing frog contact with the heart-bar area of the shoe (Figure 10). Care was taken to allow as much of the frog as possible to contact the bar of the shoe but without exerting any undue compression. From the second shoeing on, more frog contact was established as follows:

a. The shoes were fitted approximately ¼" (6mm) back from the furthermost point forward of the toe of the foot.

b. Width and caudal length were afforded to each foot within reason so as not to facilitate losing the shoes unnecessarily but offering a generous amount of platform for each foot to stand on.

c. The shoes were fitted so as to engage contact between the frog and the shoe.

The amount of contact between the frog and shoe was gauged by fitting the shoe and then placing the shoe onto the foot whilst non-weight bearing. The distance between the heels of the foot and the heel area of the shoe was set at 5mm. This was measured by the digital calipers.

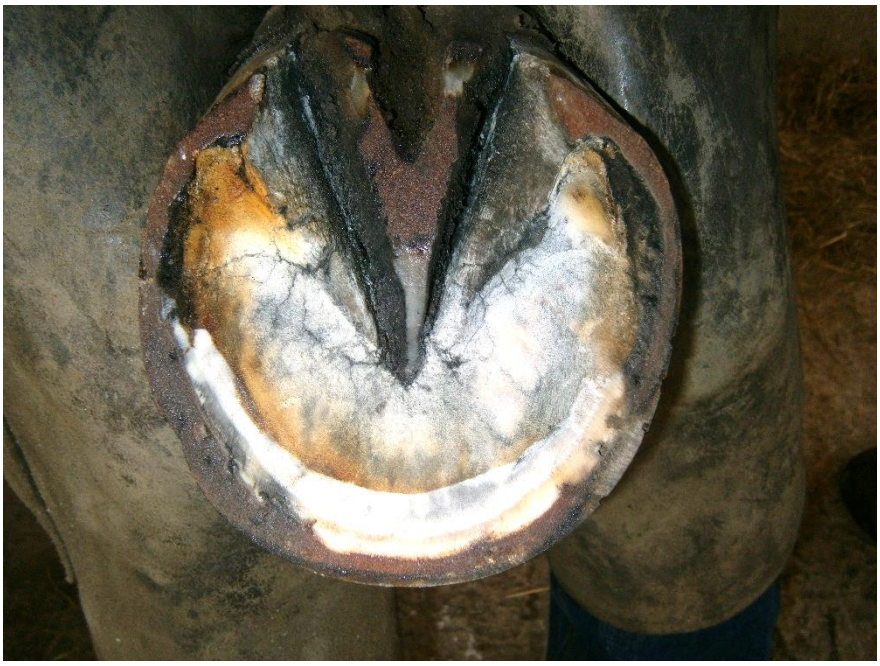

Figure 10: *Establishing frog contact on the first shoeing.*

4. The shoe was then nailed on to the foot but not finished off. This was to gauge comfort and to ensure the horse was totally happy before finishing the foot off.

5. The foot was then finished off after the other foot had been completed. Finishing involved dressing the clenches and rounding off the toe but allowing a small amount of overhang at the toe.

In some of the horses the desired amount of frog contact was not achievable by a flat heart-bar shoe. In these cases a triangular shaped insert (Figure 11) was welded to the foot surface of the shoe in order to raise the heart-bar part of the shoe. These were engineered especially

at 3mm, 5mm, 8mm and 10mm thicknesses by Winfield Engineering in Grantham. Figure 12 shows a shoe which had been removed, demonstrating the height of the insert in order to obtain the desired amount of frog contact.

Figure 11: *Triangular shaped inserts for achieving the desired amount of frog contact.*

Figure 12: *A removed shoe demonstrating the height of the insert required to obtain sufficient frog contact.*

Frequency

The initial intention was to shoe the horses every 5 weeks. The reason for this frequency was to reduce the incidence of the heels growing and minimising frog contact. This was accomplished in most cases but one of the horses lapsed considerably due to unexpected owner absence. On removal of the shoes frog contact was evident and wear patterns could be observed on the insert (Figure 13).

Figure 13: *Evidence of frog contact and demonstration of wear patterns.*

The mean shoeing frequencies for each horse are indicated in Table 2 below:

Table 2: Mean Shoeing Frequencies

Horse	Mean Shoeing Frequency	Range
A	5 weeks 2 days	3 weeks 5 days - 7 weeks 1 day
B	5 weeks 4 days	3 weeks 5 days - 7 weeks 1 day
C	5 weeks 0 days	3 weeks 3 days - 6 weeks 6 days
D	6 weeks 6 days	4 weeks 0 days - 10 weeks 6 days

Statistics

All measurements and statistics were gathered from the photographs taken using Epona Tech Metron-Hoof ™ (Version 6.06).

1. The pictures were downloaded onto a Hewlett-Packard Pavilion notebook and then imported into Metron™.

2. Each picture was then individually calibrated and measured

3. The pictures were calibrated using Wilko self-adhesive white labels measuring 53mm across. Metron™ could then give the measurements using the “guided mark-up” element of the programme.

4. After the “guided mark-up” stage each measurement was then completed using the “free mark-up” part of the programme. This allows the user to measure any two points on the photograph either in a straight line or around curves and corners.

Once all the photographs had been marked up in Metron™ (Figure 14) they were then recorded into the Excel document “Final Statistics” (Appendix 7) ready for analysis.

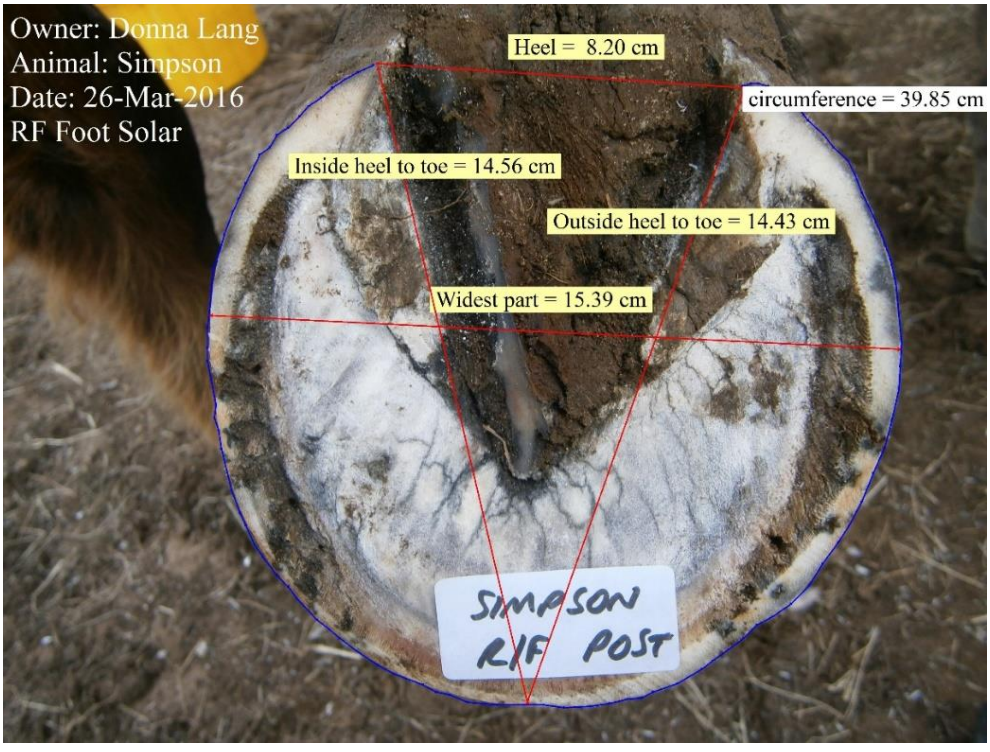

Figure 14: *Each picture was individually calibrated and measured using the Metron™ programme*

Data Analysis

All data was analysed on the Excel spreadsheet document (Appendix 7). The key measurements were the distance between the heels per shoeing. These and the changes to them were analysed throughout the 10 shoeings and comparisons could be drawn between them.

Table 3 was created to represent the heel distances at the beginning of the study, at the end of the study and also the widest and narrowest heel distances throughout the study.

The distance around the circumference of each foot was also taken. Table 4 was used to display each individual foot's circumference at the beginning of the study, at the end of the study and also the longest and shortest circumferences throughout the study.

The circumference was then added to the distance between the heels and a total was arrived at. From this figure, it was possible to represent the heel distance as a percentage of the whole perimeter of the foot including the distance between the heels. These were then recorded onto Table 5.

Results

The study recorded the changes in heel distance in each horse over a 10 shoeing period. Unfortunately, one of the study horses (Horse E) died approximately four months into the study.

Widest and Narrowest Heel Distances throughout the Study

Horse A's left-fore foot hit its narrowest heel distance mid-way through the study and its widest heel distance on the final shoeing. The increase from the first to last shoeing was 0.75cm. The right-fore heel distance on Horse A was at its widest on shoeing 1 and then finished 0.30cm narrower at the end of the study.

Horse B's left fore was at its widest on shoeing 7 and its lowest on the final shoeing showing a slight decrease in distance of 0.13cm. The right-fore showed its narrowest distance (8.51cm) early on in shoeing 3 and its widest distance at shoeing 9 (9.99cm). The overall result however was a total decrease in distance of 0.65cm.

The heels on both feet of Horse C were at their narrowest on shoeing 1. Horse C's left-fore then increased to its widest heel distance on shoeing 10. The total increase was 0.88cm. Horse C's right-fore showed the most dramatic results of the study. The heels were 4.50cm wide on shoeing 1. They then increased to their maximum distance of 6.0cm on shoeing 6, and by shoeing 10 measured 5.57cm. At the end of the study the heels represented an increase in distance of 1.07cm. The difference between their narrowest and widest distances however was 1.5cm.

Horse D showed the most consistent results throughout the study. Both fore-feet showed their widest heel distances at shoeing 2 and their narrowest heel distances at shoeing 5. The differences in the distances of both heels at the beginning of the study compared to the end were minimal.

Table 3: Widest and Narrowest Heel Distances

Horse	Shoeing Number										Result (1 to 10)
	1	2	3	4	5	6	7	8	9	10	
A Left-fore	6.48 (Dec 14)	6.97 (Jan 15)	6.70 (Mar 15)	7.10 (May 15)	6.06 (Jun 15)	6.79 (Jul 15)	6.99 (Aug 15)	7.21 (Sep 15)	6.22 (Sep 15)	7.23 (Nov 15)	+0.75
A Right-fore	7.12 (Dec 14)	7.10 (Jan 15)	5.91 (Mar 15)	6.25 (May 15)	5.94 (Jun 15)	7.01 (Jul 15)	6.53 (Aug 15)	6.26 (Sep 15)	6.67 (Sep 15	6.82 (Nov 15)	-0.30
B Left-fore	7.58 (Dec 14)	7.89 (Jan 15)	7.77 (Mar 15)	7.49 (May 15)	7.56 (Jun 15)	7.96 (Jul 15)	8.47 (Aug 15)	7.71 (Sep 15)	7.58 (Oct 15)	7.45 (Nov 15)	-0.13
B Right-fore	9.83 (Dec 14)	8.51 (Jan 15)	8.65 (Mar 15)	8.68 (May 15)	9.06 (Jun 15)	8.95 (Jul 15)	9.38 (Aug 15)	9.75 (Sep 15)	9.99 (Oct 15)	9.18 (Nov 15)	-0.65
C Left-fore	5.71 (Jan 15)	6.44 (Mar 15)	6.5 (May 15)	6.29 (Jun 15)	6.37 (Jul 15)	6.27 (Aug 15)	6.42 (Sep 15)	5.84 (Oct 15)	6.29 (Nov 15)	6.59 (Dec 15)	+0.88
C Right-fore	4.50 (Jan 15)	5.05 (Mar 15)	5.47 (May 15)	5.42 (Jun 15)	5.63 (Jul 15)	6.0 (Aug 15)	5.57 (Sep 15)	5.29 (Oct 15)	5.48 (Nov 15)	5.57 (Dec 15)	+1.07
D Left-fore	8.24 (Jan 15)	8.36 (Mar 15)	8.01 (May 15)	8.02 (Jul 15)	6.69 (Oct 15)	8.13 (Nov 15)	8.06 (Dec 15)	7.49 (Jan 16)	7.27 (Feb 16)	8.18 (Mar 16)	-0.06
D Right-fore	8.37 (Jan 15)	8.91 (Mar 15)	8.24 (May 15)	7.24 (Jul 15)	6.69 (Oct 15)	8.11 (Nov 15)	7.84 (Dec 15)	7.85 (Jan 16)	7.15 (Feb 16)	8.20 (Mar 16)	-0.17

All measurements taken from post-dressed feet

All distances shown in centimetres

Distances in black = Start or finish distances

Distances in red = Narrowest

Distances in blue = Widest

Distances in green = Differences (+ or -) between shoeing No. 1 and No.10

Circumferences of Feet

By the end of the study the circumference of every horse's foot had become longer. The increases ranged from 0.20cm (Horse B, right-fore) to 3.61cm (Horse A, left-fore). The average increase in circumference for each foot in the study was 1.64cm.

Horse A's circumference showed the largest increase in distance being 3.61cm longer at the completion of the study in the left-forefoot. The right-forefoot also showed an increase of 1.43cm.

Horse B's feet showed a small but notable increase in distance of 0.74cm in the left-fore and 0.20cm in the right-fore

Horse C showed a 2.48cm increase to the left-fore but only a 0.6cm increase to the right-fore.

Horse D was consistent throughout the duration of the study in heel distance and circumferences. The circumference of the left-fore increased by 2.01cm and the circumference of the right-fore increased by 2.09cm.

Table 4: Circumferences of Feet throughout Study

Horse	1	2	3	4	5	6	7	8	9	10	Result (1-10)
A Left-fore	37.39 (Dec 14)	39.31 (Jan 15)	38.74 (Mar 15)	38.34 (May 15)	37.53 (Jun 15)	38.87 (Jul 15)	39.37 (Aug 15)	38.91 (Sep 15)	39.06 (Sep 15)	41.57 (Nov 15)	+3.61
A Right-fore	38.55 (Dec 14)	41.45 (Jan 15)	39.28 (Mar 15)	39.72 (May 15)	38.31 (Jun 15)	37.81 (Jul 15)	38.50 (Aug 15)	38.54 (Sep 15)	39.06 (Sep 15)	39.98 (Nov 15)	+1.43
B Left-fore	36.63 (Dec 14)	37.87 (Jan 15)	36.88 (Mar 15)	36.03 (May 15)	36.10 (Jun 15)	35.66 (Jul 15)	36.43 (Aug 15)	36.0 (Sep 15)	36.69 (Oct 15)	37.37 (Nov 15)	+0.74
B Right-fore	36.81 (Dec 14)	36.82 (Jan 15)	36.09 (Mar 15)	36.55 (May 15)	35.69 (Jun 15)	36.45 (Jul 15)	36.01 (Aug 15)	37.22 (Sep 15)	37.51 (Oct 15)	37.01 (Nov 15)	+0.20
C Left-fore	34.83 (Jan 15)	36.69 (Mar 15)	36.17 (May 15)	35.63 (Jun 15)	35.34 (Jul 15)	36.49 (Aug 15)	35.60 (Sep 15)	34.32 (Oct 15)	36.82 (Nov 15)	37.31 (Dec 15)	+2.48
C Right-fore	34.33 (Jan 15)	35.87 (Mar 15)	34.99 (May 15)	34.67 (Jun 15)	35.41 (Jul 15)	35.83 (Aug 15)	34.88 (Sep 15)	34.53 (Oct 15)	35.93 (Nov 15)	34.93 (Dec 15)	+0.6
D Left-fore	37.08 (Jan 15)	37.29 (Mar 15)	38.08 (May 15)	38.16 (Jul 15)	37.82 (Oct 15)	40.47 (Nov 15)	39.61 (Dec 15)	37.62 (Jan 16)	38.94 (Feb 16)	39.09 (Mar 16)	+2.01
D Right-fore	37.76 (Jan 15)	36.63 (Mar 15)	37.99 (May 15)	37.90 (Jul 15)	37.82 (Oct 15)	39.28 (Nov 15)	39.31 (Dec 15)	38.85 (Jan 16)	38.63 (Feb 16)	39.85 (Mar 16)	+2.09

All measurements taken from post-dressed feet

All distances shown in centimetres

Distances in black = Start or finish circumferences

Distances in red = Shortest

Distances in blue = Longest

Distances in green = Differences (+ or -) between shoeing No. 1 and No.10

Heel Distances as Percentages

Three of the eight feet showed an increase in heel distance at the end of the study, the remainder showing a decrease. The increases were however in the three most contracted feet of the eight. Horse A's left-fore foot was contracted prior to the commencement of the study and increased by 0.35% by the end.

The most noteworthy results were seen in both feet of Horse C. This horse had two contracted feet prior to the commencement of the study, the right-fore being quite severely contracted. The heel distance of the left-fore foot of Horse C increased by 0.93% and the

right-fore increased by 2.16%. These results were taken from the statistics of the first and final shoeings.

The distance between the heels was measured and added to the circumference of the foot. This distance was then worked out as a percentage.

Table 5: Heel Distances as a Percentage

Horse	First Shoeing	Final Shoeing	Result (as a percentage)
A Left-fore	14.47%	14.82%	+0.35%
A Right-fore	15.59%	14.57%	-1.02%
B Left-fore	17.15%	16.62%	-0.53%
B Right-fore	21.08%	19.87%	-1.21%
C Left-fore	14.08%	15.01%	+0.93%
C Right-fore	11.59%	13.75%	+2.16%
D Left-fore	18.18%	17.30%	-0.88%
D Right-fore	18.14%	17.07%	-1.07%

All measurements taken from post-dressed feet

Percentages in blue = greater distance post study

Percentages in red = lesser distance post study

Discussion

The study demonstrated that the three most contracted feet at the beginning of the study were the only ones which had increased in terms of distance between the heels by the end of the study. All the other feet showed varying degrees of decrease at the conclusion. It also appeared by the results that the more the contraction of the heels at the beginning, the greater the increase in distance at the end.

The medial heel of Horse A's left forefoot was contracted inwards at the beginning of the study and the medial and lateral heel distance only represented 14.47% of the whole

circumference and heel distance when added together. By the end of the study this had increased by 0.35% to 14.82%. It was not clear from the final pictures however whether the medial heel had moved out or whether the increase in width was equal between the medial and lateral heels.

The biggest results were seen in Horse C. Horse C had existing asymmetric feet in that the left fore was bigger than the right fore at the beginning of the study. The right forefoot was very contracted with a heel distance of only 11.59% or 4.5cm at the beginning of the study. By the end of the study the heel distance had increased considerably to 13.75% or 5.57cm. The heels of Horse C were at their widest point on shoeing number 6, where they increased to a distance of 6cm.

The reasons for this could be related to the fact that they were contracted to begin with and therefore had the scope to expand to something like their previous form. Another reason could be linked to exercise. Horse C was used far more frequently than the other three horses for riding and competition work. This exercise could have increased the dynamic function of the foot to allow the heels to expand and remain further apart. The foot may have modified itself according to the requirements brought about by the exercise regime into a form where it was best suited to deal with the stress and weight-bearing placed upon it.

There appeared to be no significance or relationship between the environmental conditions and the distance between the heels. The horses were all shod 10 times overall and there appeared to be no link between the atmosphere being damper or drier. The feet did not expand more during wet conditions and did not contract more during the drier summer months. In fact, the results were fairly evenly spread throughout the study and were not

weighted in any particular area.

Circumference measurements of the feet were also taken and analysed throughout the study. These were relevant because they showed whether the feet had distorted, or become bigger or smaller. If the circumference of the feet had remained the same and the heel distances had increased then it could be assumed that the reason for this was due to frog loading. If the heel distance had remained the same and the circumference had increased then the effects of the frog loading would have been evident by an increase in the distal border of the hoof capsule.

The amount of frog contact/pressure was determined using a measurement of 5mm using the digital calipers. The problems associated with this were that the amount of contact/pressure was unquantifiable in terms of force applied onto the frog. It was achieved by inserting the device and allowing a 5mm gap between the heels of the foot and the heels of the shoe before application. Although this was consistent with every horse and proportionate to each horse's weight, the amount of pressure applied would be more accurately determined with the use of a force measuring device. Future studies into this area would be more accurate and consistent if the amount of force was regulated and quantifiable.

The study initially involved 5 horses but was reduced down to 4 due to one of the horses dying. Reducing the study population by 20% limited the significance of the results further to its existing limitations. Future studies would be more accurate with a wider population of horses and also with a greater age range. All selected horses used for the study were mature horses between the ages of 11 and 19. It would have been more representative to include some younger horses.

Although the shoeing frequencies were generally adhered to, one of the horses went a considerable length of time between two of the shoeings. Although this was beyond the control of the author it was disappointing and alternative arrangements should have been made with each horse to cater for unforeseen circumstances. The problems associated with prolonged periods between shoeings are primarily that as the heels of the foot grow, the contact between the frog plate of the shoe and the frog of the foot decreases. It was noted however that each time the shoes were taken off the foot, mud and earth had kept the frog in a compressed state. Future studies should include a contingency for a change in the horse-owner's circumstances.

Pictures were taken throughout the study. Comparisons were drawn between the pictures taken at the beginning of the study and at the end (Figures 15 and 16). It was noticed that the frogs were in a worse condition at the end, probably as a result of having the heart-bars on for a prolonged period of time. Necrosis was present in the frogs and the structure seemed to have been compromised. Deacon (1999) observed that if horses are to be shod in heart-bars for any length of time, it is sometimes wise to give the feet and occasional "rest" by shoeing them in a straight-bar for one shoeing only. The author would most definitely agree with this as a result of this study.

Figure 15: *The frog at the beginning of the study in a healthy state.*

Figure 16: *The frogs at the end of the study appeared to have deteriorated and suffered necrosis as a result of prolonged application of the heart-bar shoe.*

Conclusion

In conclusion, a case series method was chosen utilising a small sample of five horses which was subsequently reduced to four. The aim was to ascertain whether long term positive loading to the frog has any influence or bearing on the distance between the heels of the foot. The research demonstrated that the changes in the heel distances which increased by the end of the study were only minimal. The research, however has provided

a number of interesting findings which warrant further research.

It became apparent throughout the study that certain key variables may have had an influence on the outcome of the study. Horse C, for example, demonstrated the greatest difference between heel width, and it was noted that Horse C had the greatest and most consistent workload, whereas the rest of the sample spent more time at rest. It would be useful therefore, to investigate further the extent to which the amount and type of workload impacts upon frog pressure and subsequent changes to heel width.

It was also noted during the study that the frog health deteriorated with the prolonged use of the heart-bar shoe. It is unknown whether this was due to the pressure applied to the frog or whether the cause could be attributed to this type of shoe providing an environment conducive to bacterial or fungal infections.

Overall, this research has provided an interesting preliminary study, which has highlighted areas for further research using a larger sample, particularly into the relationship between the positive loading of the frog and contributing factors such as workload and frog health on the distance between the heels.

Manufacturers' Addresses

1. Metron Epona Tech - EponaShoe P.O. Box 361 Creston, CA 93432,
2. Olympus D-745 - KeyMed House , Stock Road, Southend-on-Sea, SS2 5QH
3. Halfords Digital Vernier Calipers - Halfords Group plc, Washford West, Redditch, Worcestershire, B98 0DE
4. Microsoft Excel - Microsoft Headquarters, 1 Microsoft Way, Redmond, WA 98052,
5. Artline White Marker EK-400 XF - Shachihata (Europe) Ltd. Unit 8, Ashville Way, Sutton Weaver, Runcorn, Cheshire, WA7 3EZ, England
6. 53mm Self Adhesive Labels - Wilko, JK House, Roebuck Way, Manton Wood, Worksop, Nottinghamshire, S80 3EG,

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Appendices

Appendix 1:

Horse A	
Breed:	Irish Draught
Age:	12 at the time of the conclusion of the study
Sex:	Male (Gelding)
Height:	16.2hh
Weight:	Approximately 532 kg
Colour:	Dark Bay
Conformational Assessment:	Upright conformation,
Foot/Hoof Conformation:	Asymmetric front feet. **Left-forefoot:** Contracted on medial heel, bold outside Lateral side always higher than medial side (M/L balance) Slightly more upright than right-fore (tends to grow lots of heel) Sustained a check ligament injury to inferior Check lig whilst in the Army **Right forefoot:** Better shape of foot, bolder than left-fore More sloping foot than left-fore Both frogs atrophied and small for the size of feet
Accommodation:	Lives out in the field Stabled occasionally
Work Regime:	Light hacking
History:	Ex King's Troop horse, worked in a Gun Team until sustaining a check ligament injury to left-fore sub-carpal check ligament Long term lay-off at Melton Mowbray where work tested and passed fit. Has hunted many times and show-jumps occasionally

Appendix 2:

Horse B	
Breed:	Cleveland Bay
Age:	18 at the time of the conclusion of the study
Sex:	Female
Height:	16.2hh
Weight:	Approximately 540 kg
Colour:	Light Bay
Conformational Assessment:	Sloping conformation, long patterns in front and hind Long in the back, quite weak/slight behind
Foot/Hoof Conformation:	Asymmetric front feet. **Left-fore:** Smaller foot but not necessarily contracted, slightly more upright than right-fore **Right-fore:** Bigger foot and more sloping than left-fore, bolder shaped foot Good strong frogs, good size and consistency
Accommodation:	Lives out in the field Stabled occasionally
Work Regime:	Light hacking Occasionally lunged and lead from another horse
History:	Used for riding club work, schooling, low level eventing Has jumped in the past Diagnosed with spavin in both hock joints approximately 7 years ago. Never really affected movement or prevented her from working

Appendix 3:

Horse C	
Breed:	Welsh Section D crossed with Dales
Age:	19 at the time of the conclusion of the study
Sex:	Male (Gelding)
Height:	14.1hh
Weight:	Approximately 414 kg
Colour:	Light Bay
Conformational Assessment:	Very upright conformation particularly through the shoulder and HPA Compact, good bone/legs
Foot/Hoof Conformation:	Asymmetric front feet (left-fore considerably larger than right-fore) **Left-fore:** Very narrow and contracted, particularly between the heels. Square in the toe, very straight between toe quarters and heel quarters, heel quarters break very late Frog narrow but healthy **Right fore:** Considerably more contracted, foot very narrow and long Straight in the quarters Frog small and very narrow
Accommodation:	Lives out in the field in the summer, in during the winter months Stabled regularly throughout the year
Work Regime:	Regular hacking Competes regularly at lower level events. Used for riding club work, schooling, good all-rounder.
History:	Diagnosed with low ringbone in both forefeet (worse in the right fore) approximately 4 years ago. Arthritis is non-articular being present on the P3 only. Occasionally unsound due to the ringbone (usually on the hard ground or uneven surfaces).

Appendix 4:

Horse D	
Breed:	Belgian Warmblood
Age:	15
Sex:	Male (Gelding)
Height:	16.1hh
Weight:	Approximately 504kgs
Colour:	Light Bay
Conformational Assessment:	Good conformation, well-proportioned and strong HPA good, no conformational issues
Foot/Hoof Conformation:	Feet appear symmetrical, both the same size and angle No foot issues other than weak wall occasionally on both front feet (medial), largely down to the owner leaving him a little too long between shoeing and loading the insides. Frogs fairly strong and function well
Accommodation:	Lives out in the field all year round Stable is available but only used if there's a problem
Work Regime:	Formerly a showjumping horse in Belgium. Been in the UK for approximately 9 years. Since UK arrival regular hacking through summer months, not much throughout winter other than weekends.
History:	No known issues regarding lameness or previous illness. Is generally a sound horse with no lumps or blemishes.

Appendix 5:

Dear *(Horse owner's name)*

Thank you for provisionally agreeing to your horse being included in my proposed study. The study is part of my Fellowship of the Worshipful Company of Farriers (WCF) dissertation.

Background

Farriery is full of suppositions. Many of these are anecdotally shared from one generation to the next with little or no scientific research to either prove or disprove them. The reason for my proposed study is to test one of these suppositions.

Aim

The aim of my study is measure the effects of positive frog loading on the distance between the heels of the foot.

Outline

- The study will last for approximately 10 shoeings from the commencement.
- Your horse will be shod regularly throughout this time (the frequency will depend on time of year, rate of foot growth, your availability and my availability).
- The work will be carried out at my forge each time (this is to ensure accuracy and precision regarding the amount of frog contact for each shoeing).
- Each shoeing (pair of front shoes) will take approximately 1 hour and will involve the measuring and recording of several statistics on your horse's feet.
- All measurements, details and data acquired remain confidential and you or your horse will not be named or identified.
- I am totally happy to update or answer any questions throughout the study, please don't hesitate to ask if you have any concerns whatsoever.
- The welfare of your horse is paramount at all times
- Should you wish to terminate your participation at any time please do.
- A copy and explanation of my dissertation will be available to you should you desire one upon completion.

Should the dissertation be accepted by the Worshipful Company of Farriers then for the good of education and progression in the trade of farriery I will accept invitations to speak on the results.

If you are happy with the terms laid out above then please sign this form below and return to me. Should you be unsure of anything or require further clarification then please contact me at your earliest convenience.

A copy of this form will be made available to you.

Thank you.

Signed: Date: Signed: Date:

M. Watson AWCF *(Horse Owner)*

Appendix 6: Mark Watson – Thesis Statistics Gathering Form

Owner's Name: _____

Horse's Name: _____ Date: _____

Left-Fore Dressing Statistics

Measurement	Pre-dress (cm)	Post-dress (cm)
Width (widest part to widest part)		
Inside heel to toe		
Outside heel to toe		
Circumference		
Medial heel to true point of heel		
Lateral heel to true point of heel		
Heel distance		

Right-Fore Dressing Statistics

Measurement	Pre-dress (cm)	Post-dress (cm)
Width (widest part to widest part)		
Inside heel to toe		
Outside heel to toe		
Circumference		
Medial heel to true point of heel		
Lateral heel to true point of heel		
Heel distance		

Results Pre-dress

Measurement	Front Left (cm)	Front Right (cm)
Heel distance + circumference		
Heel distance as a percentage		

Results Post-dress

Measurement	Front Left (cm)	Front Right (cm)
Heel distance + circumference		
Heel distance as a percentage		

Appendix 7: Final Statistics