



Farriers play an integral role in keeping hooves in optimal condition

Measuring Up

RESEARCHERS EXAMINE GAUGING TECHNIQUES IN **HOOF EVALUATION**

By AMANDA DUCKWORTH

GIVEN THE IMPORTANCE of hoof health in horses, it should come as no surprise that it's a heavily researched and studied aspect of equine anatomy. The more that is understood about the hoof the better, for both horses and the humans in charge of their well-being. From basic conformation to dreaded diseases such as laminitis, knowledge is power.

The American Association of Equine Practitioners has a wealth of information concerning hoof basics, and Dr. Brad Jackman authored "The Equine Foot" for the organization.

"Lameness is the largest cause of economic loss in the equine industry," Jackman wrote. "The most common location of forelimb lameness is the foot. There is a greater chance for a successful outcome if the lameness is addressed at its onset and a complete examination and workup is performed.

"Since the foot is the foundation of the horse, foot problems are best avoided if possible. That is best achieved with the horse having good limb and foot conformation to start, and then maintaining good conforma-

tion and support with good shoeing."

For all of the research that has been done, there are still aspects of the hoof that lend themselves to continued study, especially as technology advances. In August 2022, the *Journal of Equine Veterinary Science* published "An Investigation Into Different Measurement Techniques to Assess Equine Proximal Hoof Circumference."

"Equine hoof conformation is integral to equine performance and soundness," said researchers. "Consequently, it is a major area of interest within the field of equine health. Researchers have measured several hoof shape parameters to study the hoof conformation. Proximal hoof circumference (PHC) is a primary hoof shape parameter, and its assessment may help to recognize the early stages of the development of changes in hoof morphology or poor hoof shape.

"Previous studies have mainly used a measuring tape to measure PHC. However, some doubts still exist regarding the reliability, repeatability, and accuracy of measuring tape in this context."

For the study, researchers conducted a technical comparison between the measuring tape and two alternative methods—3D scanning and photogrammetry—to measure PHC. The PHC of five equine limbs from five adult horses was measured using the three methods. The horses included had died for reasons unrelated to the current study, and the limbs had normal hoof conformation. The 3D scanner was anticipated to be the most accurate and was used as reference for method comparisons. Researchers used pairwise correlations between it and the other two methods using a linear mixed model.

"The measuring tape and photogrammetry tended to overestimate the mean PHC compared to the 3D scanner by 0.96 mm and 2.2 mm,

respectively,” researchers concluded. “In addition, an excellent interrater and intrarater correlation coefficient index was reported for the reliability of the tape measurements. The variation of the tape measurements was ± 2 mm, which justified the use of measuring tape for PHC measurements in various clinical and horse management applications.

“Through the application of statistical analysis on several trials, it was concluded that the conventional tape measurements, when conducted by an expert, would yield higher accuracy than the photogrammetry and comparable reliability and accuracy compared with the 3D scanner.”

In February 2023, the *Journal of*

Equine Veterinary Science published “Comparison of Six Different Methods for Measuring the Equine Hoof and Recording of its Three-Dimensional Conformation.”

“The determination of limb and hoof conformation by visual assessment is part of every orthopedic examination in equine medicine,” researchers explained. “This subjective classification can be supplemented by the use of objective measurements. There are a number of objective methods available for the evaluation of the hoof conformation that are suitable and have already been used to determine the shape of the hoof.”

While there are a number of established methods for evaluation, re-

searchers were interested in examining the efficacy of a potentially new method for horses: the MicroScribe.

“A novel tool that might prove useful for taking measurements of the hoof without the necessity of prior reconstruction is the MicroScribe tool, a portable measuring device with a flexible arm to collect surface coordinates by touching the object. This method has already been used for quantitative anatomical research in humans. For horse studies, the MicroScribe has been used only rarely.

“To our knowledge, the direct generation of quantitative data describing the equine hoof shape using the MicroScribe tool has not yet been validated and compared with other methods

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that are generally used for hoof measurements. Therefore, the aim of this study was to compare biometric data of the equine hoof collected by the MicroScribe tool with measurements collected directly from hooves, from scaled photographs and radiographs, as well as from 3D models generated by the photogrammetry technique and CT datasets.”

For the study, researchers took 62 measurements from 16 cadaver front limbs. The six different methods were employed to collect the measurements, with 21 linear and nine angular measures being collected by at least four methods each. Researchers found 10 of the linear measures could be collected by all six methods, five by five methods, and the remaining six by four methods.

“All methods provided homogeneous result with similar spread and few outliers,” researchers reported. “In some cases, different methods measure different structures. Radiographs tended to overestimate, while computed tomography tends to underestimate distances. Photogrammetry and scaled photographs were less suitable for measuring hoof angles. The MicroScribe tool can readily be used for hoof measurements. Its values for linear measures showed good equivalency with other methods based on real hooves. For angular measurements, the uneven hoof surface might introduce imprecision. Not all hoof conformations could be detected based on measuring results alone. Diagnosis by a skilled veterinarian is still essential.”

In addition to natural hoof conformation, other factors such as how and when horses are shod as well as the types of surfaces they exert themselves on can have a tremendous impact on equine soundness.

The *Journal of Animal Science* published “Short Communication: Changes in gait after 12 weeks of shoeing in previously barefoot horses” in January 2023.



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— DR. BRAD JACKMAN

“Farriery can impact gait symmetry and lameness outcomes, but there is limited scientific data documenting these effects,” the researchers said. “We hypothesized that shoeing previously barefoot horses with plain stamp shoes on the hind hooves would increase gait symmetry, alter hock angles and increase range of motion, and improve lameness scores more than shoeing with traditional fullered shoes.”

For the study, 14 unshod horses were evaluated using wireless inertial motion sensors (IMS), kinematic gait analysis (hock angle and range of motion), and the AAEP’s lameness scoring. The horses were then trimmed and received either three-quarter fullered shoes or plain stamp style shoes on their hind hooves. They were trimmed and reshod six weeks later. At the end of 12 weeks, all of the

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Tools to measure the hoof may help detect disease in its early stages

previous analysis was repeated.

“No differences were observed in the IMS scores, hock angles or range of motion, or AAEP lameness scores between horses shod in fullered or plain stamp shoes,” researchers concluded. “As no variables were determined to be significantly different between the two shoe types, data from all horses were combined to analyze the differences between the barefoot and shod state.”

“Shoeing increased the maximum angle of the right and left hocks and the minimum angle of the left but not right hock relative to barefoot conditions. No differences in hock range of motion were observed in either hock. Lower AAEP lameness scores were observed in horses when shod compared with barefoot. In conclusion, shoeing previously barefoot horses improved AAEP lameness scores and increased hock angles, regardless of the type of shoe.”

In August 2022, *Animals (Basel)* published “Hoof Impact and Foot-Off Accelerations in Galloping Thoroughbred Racehorses Trialling Eight Shoe-



A common location of forelimb lameness is the foot and there is a better chance for a successful outcome if the lameness is diagnosed quickly through examination

Surface Combinations.”

“Whole horse kinematics and injury mechanics are influenced by hoof-surface interactions,” researchers found. “Establishing factors that control the timing and patterns of equine hoof motion throughout a stride cycle is necessary for optimizing equine biomechanical function and performance, lessening the risk of injuries and enhancing economic gains.”

“Thoroughbred racehorses galloping at high speeds during training and racing are particularly vulnerable to injuries. As a result, the racing industry are placing increasing emphasis on understanding intrinsic and extrinsic factors that modulate a horse’s output on the track.”

For this study, researchers investigated the hoof accelerations of 13 Thoroughbreds in four different shoeing conditions at a gallop both on turf and artificial surfaces. The horses used in the study were in regular work as they were used for jockey education at the British Racing School. They were considered sound prior to data collection and ranged in age from 6 to 20 years old.

Throughout the study, the same horse-and-jockey pairings were used, while the shoe-surface condition varied. For various reasons related to availability and injury, not all horse-jockey pairings completed the trials in all conditions. Researchers studied aluminum, barefoot, Glushu, and steel shoes. A total of 41,183 strides were included in the analysis.

“Tri-axial hoof accelerations at impact and foot-off in galloping Thoroughbreds were influenced by the horses’ shoeing condition and surface type,” explained researchers. “Accelerations were elevated at impact on the turf surface compared to the artificial track by 1.2–2.4 times across limbs, depending on the acceleration axis considered; acceleration magnitudes were largest and offsets between

surfaces greatest along the hoof wall and in the dorso-palmar direction. Accelerations were, on average, 2-18% higher at impact in the shod conditions compared to barefoot, when considering all acceleration axis directions together, but they rose up to 30% more in steel. Preventing excessive shock loading and related musculoskeletal injuries in racehorses is of critical relevance to the racing industry.

“Barefoot hooves generally experienced the lowest accelerations. The stride time affected all impact and foot-off accelerations. Identifying factors influencing hoof vibrations upon landing and hoof motion during propulsion bears implication for injury risk and racing outcomes.”

In addition to conformation, shoe-

ing, and surface, researchers have also recently examined the impact age might have on limb soundness. In December 2022, the *Equine Veterinary Journal* published “Effect of age at training initiation on hoof morphology and lameness in juvenile American Quarter Horses.”

“Lameness, discipline, training intensity, environmental variability, and shoeing are all factors demonstrated to affect hoof loading and therefore act as adaptive stimuli to alter hoof morphology,” researchers reported.

The objective of the prospective cohort study was to evaluate the effect of age at training initiation on hoof morphology and lameness incidence and determine if specific hoof morphology measurements correlate with lameness

in juvenile American Quarter Horses.

A total of 42 American Quarter Horses were used in the study, including 29 2-year-olds and 13 3-year-olds. They were all entering training and were monitored for hoof morphology and lameness over the span of six months, with analysis being done at the zero, two, four, and six-month markers.

Hoof measurements—ranging from palmar/plantar angles, frog base width/length, toe length/angle, heel length/angle, heel and foot width, wall height/angle—were recorded from radiographs and photographs, while lameness was graded subjectively and objectively.

Researchers found 25 out of the 42 horses developed subclinical lameness, with 16 having lameness in the forelimb and 19 in the hindlimb.

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Hoof Health

“Three-year-old American Quarter Horses entering training were more likely to develop forelimb lameness than 2-year-olds,” researchers concluded. “This subclinical lameness was associated with specific hoof morphology characteristics.

“Three-year-olds developed lameness more frequently compared to 2-year-olds overall and in forelimbs; no difference was noted between 2- versus 3-year-olds in hindlimbs. In lame versus sound forelimbs, 3-year-olds had decreased foot width, decreased toe length, shorter lateral wall height, and shorter medial wall height. In lame versus sound hindlimbs, horses overall and 3-year-olds had longer heels.”

Equine hoof conformation and how it adapts to the lifestyle of the horse will always play a large role in whether or not a horse stays sound. Better understanding of the best ways to analyze hooves as well as how factors such as age, training, shoes, and ground surfaces impact a horse can only prove valuable to those in charge of their care. **BH**



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Thoroughbreds are particularly prone to hoof injuries because of the high rate of speed at which they travel

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