The Hock Examined

The anatomy, conformation, and movement of this critical joint

BY HILARY M. CLAYTON, BVMS, PHD, MRCVS

THE HOCK JOINT IS IMPORTANT both as a key joint in determining performance ability and also as a frequent site of lameness, not only in dressage horses but in horses competing in all types of equestrian sports. Staff and students at the McPhail Equine Performance Center have been actively engaged in a number of studies designed to provide information about the function and dysfunction of the hock joint. These studies have been possible thanks to a grant from the Bernice Barbour Foundation. This column will describe the results of some of these studies and the implications for dressage riders and trainers.

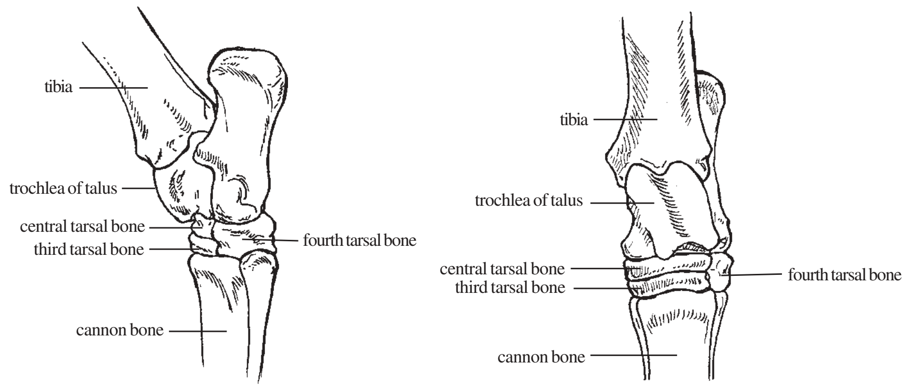

Figure 2. The bones of the left hock joint, as seen from the lateral (left) side and from the front (right).

Hock Anatomy

The hock joint is equivalent to the human ankle (Figure 1). In humans, the bones of the ankle and foot, which include the metatarsals and the phalanges, lie flat on the ground, bearing weight directly from below. The underside of the foot is called the plantar side, and this type of stance is called plantigrade stance.

One of the adaptations associated with the horse's cursorial (adapted for running) lifestyle is that the bones of the digit have been elevated from the ground. The weight is borne by the structures on the underside of the hoof: the hoof wall, which is a greatly strengthened toe or fingernail; the sole, and the frog. This type of stance is called unguligrade stance, from the Latin word *unguis* (nail).

The horse's metatarsals and phalanges have been raised from the ground and are relatively longer than the equivalent bones in the human. As a result, the hock joint is located midway up the leg and is part of the chain of limb bones that carry the horse's weight and provide locomotor forces.

The hock is a complex joint that comprises six bones and the joints between them (Figure 2, above). These bones and joints are arranged in three main layers:

1. *Upper (proximal) layer*: talus and calcaneus
2. *Middle layer*: central tarsal bone
3. *Lower (distal) layer*: first and second tarsal bones (which are usually fused), and third tarsal bone. ➤

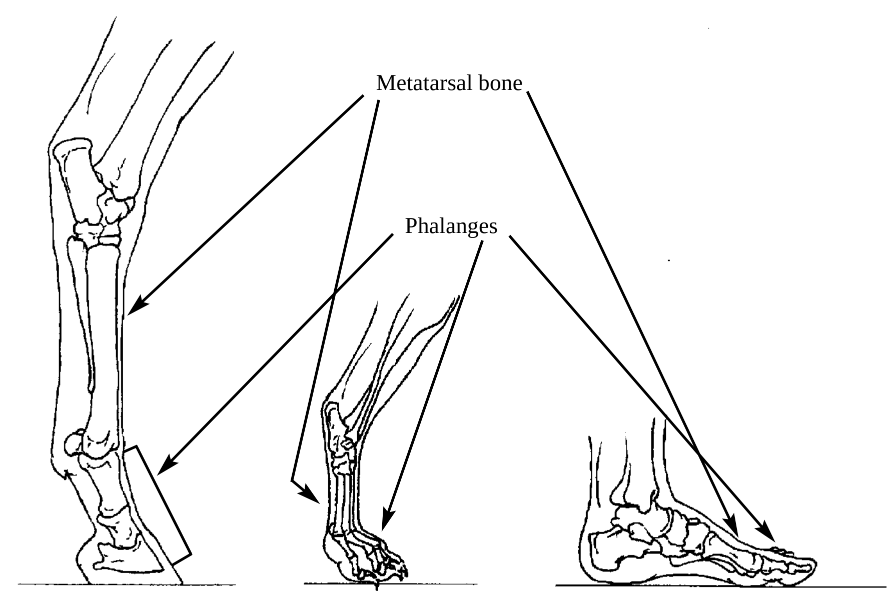

Figure 1. Weight-bearing structures of the right foot in the horse, dog, and human. In the human, the ankle and the bones of the digit are flat on the ground. In the horse, weight is borne on the tip of the toe; the metatarsal (cannon) bone and the phalanges (pastern and coffin bones) are elevated from the ground and elongated, compared with the same bones in the human.

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The fourth tarsal bone spans the middle and distal layers at the back of the joint.

The bones of the hock are firmly anchored to the top of the cannon bone, the result being that the entire hock acts like an upward extension of the cannon bone. The tibia (the leg bone that connects the hock to the stifle) rotates around the smooth, rounded trochlea of the talus at the tarsocrural joint. This is the most mobile joint in the entire hock-joint complex. Highly mobile joints typically have extensive joint capsules and copious synovial fluid, which helps to lubricate the joint. The tarsocrural joint has a voluminous joint capsule, which sometimes becomes overly distended with fluid, resulting in a bog spavin. In this condition, the joint capsule bulges at the front of the joint and, to a lesser degree, behind the talus. Characteristically, if the swelling at the front of the hock is squeezed, the fluid is redistributed and the swelling behind the joint becomes more prominent.

The calcaneus forms the point of the hock, which provides leverage to the muscles that extend the hock joint to provide propulsion during locomotion. This bone is stabilized by a ligament that runs down the back of the hock, from calcaneus to cannon bone. The high forces exerted on the calcaneus sometimes tear this ligament, resulting in the development of a curb, which appears as a firm swelling on the back of the hock.

The central and third tarsal bones are shaped like broad, flat slabs; and their articular surfaces are flattened in a horizontal plane. The bones' flattened shape allows the joints between them to rotate and slide a little bit but precludes flexing and extending movements. "Bone spavin," or arthritis of the hock, occurs at the distal tarsal joints and is usually located on the inner side, at the front of the hock.

Hock Conformation

In evaluating hock conformation, it's necessary to consider the location of the hock in relation to the entire hind limb as well as the angulation of the joint itself. Unless you are very experienced in evaluating conformation, look at the horse in a standard pose: from the side, with the front limbs vertical and the hind limbs positioned so that the point of the hock is beneath the point of the buttock (Figure 3, below). The angle of the hock is the angle between the tibia and the cannon bone on the front of the joint.

In his studies of the conformation and gaits of Swedish Warmbloods, veterinary researcher Dr. Mikael Holmström found an average hock angle of 156 degrees in the general population, with elite dressage and jumping horses having larger angles—around 159 degrees. At the McPhail Equine Performance Center, we have measured standing hock angles in warmbloods, Andalusians, Thoroughbreds, Standardbreds, and Arabians. We found that the majority of horses fall within the range of 155 to 165 degrees but that some are 10 degrees higher or lower than these values. Studies are ongoing to evaluate the effect of hock angulation on motion and performance.

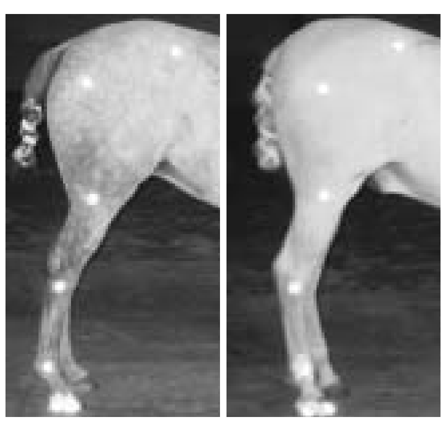

Figure 3. Horses with different hock conformations, photographed in a standard pose, with the point of the hock vertically below the point of the buttock. At left: straight hind leg. At right: sickle hock and forward-sloping cannon bone.

One thing we've found is that the angulation of the cannon bone is more informative than the angle of the tibia in classifying the type of hock conformation. In horses with a small hock angle (sickle hocks), for instance, the cannon bone slopes forward when the horse stands in the standard pose. This is evident in Figure 3, which shows the angles of the limb segments in horses with large and small hock angles. We defined a large angle as greater than 165 degrees and a small angle as less than 155 degrees.

The lengths and angulations of the bones of the pelvis, femur, and tibia determine the location of the hock joint beneath the horse's body and its cycle of movement as he travels. A more sloping pelvis places the hip joint a little lower and farther forward than does a flatter pelvis. The femur slopes forward from the hip joint: The greater the length and the more forward the angulation of the femur, the farther forward it places the stifle and hock beneath the body. Conversely, a femur that is short or that has a more vertical angulation places the stifle and hock farther back, relative to the hip joint. The tibia slopes backward from the stifle joint: Greater length or a more backward angulation places the hock farther out behind the horse. The ideal sport horse has a long, forward-sloping femur and a tibia that is neither excessively long nor sloping.

The Hock's Role in Movement

In observing the motion of the hock joint, we evaluate both the path followed by the entire hock during the stride and the relative motion between the tibia and the cannon bone. The path of the hock is assessed in terms of the amount of *elevation* (raising and lowering), *protraction* (forward motion beneath the body), and *retraction* (pushing out behind the body). Relative motion

PHOTOGRAPHS COURTESY OF THE MCPHAIL EQUINE PERFORMANCE CENTER between the tibia and cannon bone is indicative of movement between the individual bones of the hock joint.

Movement of the entire hock relative to its standing position is produced by undulations of the pelvis and by movement in the hip and stifle joints. Undulation of the pelvis is a consequence of flexion of the lumbosacral joint, which is located behind the saddle in the croup region. When this joint flexes, the pelvis rotates forward, the hindquarters tuck under, and the cycle of hind-limb motion tends to be more forward under the body mass. To visualize this movement, think of a reining horse performing a sliding stop with his hind limbs brought forward under his body.

A dressage horse's pelvis tends to oscillate in rhythm with his limb movements, tucking under as his hind limbs swing forward. The forward-and-backward swinging motion of the hind limb originates in the hip joint. Suppleness in the hip enables the hind limb to have a large range of motion, not only forward and backward but also from side to side. We like to see the hind limbs work underneath the horse's body instead of pushing out behind because this makes them more effective in performing their carrying and propulsive functions. Although we tend to evaluate the position and engagement of the hind limbs based on the positions of the hocks and hoofs, it is the movements of the hip that are the most influential in moving the entire hind limb relative to the rest of the body.

The position of the hock relative to the body changes with training as the horse develops the range of his gaits, from collection to extension. Dr. Holmström's research indicated that there is no difference in the amount of protraction (forward motion) of the hock—specifically, that the hock is not carried farther forward in the collected

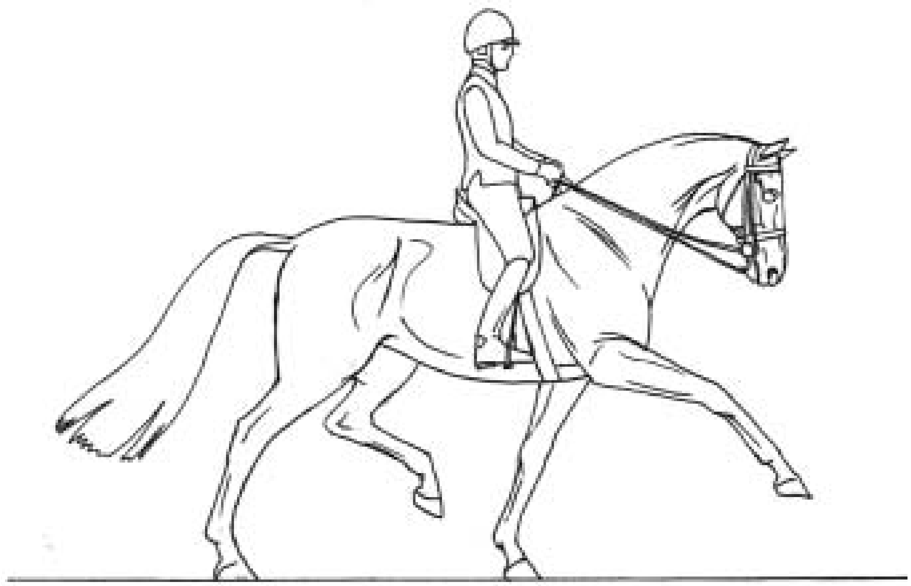

Figure 4. Extended trot, showing the range of motion of the hock joint. The right hind limb shows maximal extension as the horse pushes off at the end of stance. The left hind limb shows maximal flexion during the swing phase.

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gaits. What does change, however, is the amount of retraction: In the highly collected gaits, such as piaffe, the hind limbs show minimal retraction; whereas in the medium and extended gaits they have a wider cycle of movement that carries the limb farther backward. One of the goals of dressage training is for the horse to learn to provide the necessary propulsive forces without pushing out too far behind his body, even in the extensions.

The movements of the hock joint itself are primarily flexion and extension around the tarsocrural joint, where the tibia rotates around the trochlea of the talus. These are the movements that we see when we view a horse from the side. When the horse flexes his hind leg, the angle at the front of the hock gets smaller; during extension, this angle increases (Figure 4, above).

During a trot stride, the hock undergoes two cycles of flexion: one during the stance phase and a second during the swing phase. When the hind hoof contacts the ground, the hock angle is similar to the standing angle: Horses with straight hocks have larger angles at contact than those with sickle hocks. During the early part of the stance phase, the hock joint flexes by 12 to 15 degrees. As it flexes, it absorbs concussion associated with the impact of the hoof with the ground. A large amount of hock flexion in the stance phase gives the impression of supple and fluid motion and produces more lowering of the haunches. In the later part of the stance phase, the hock joint extends as it generates propulsion to drive the horse forward. The joint reaches its maximal extension around the time the hoof leaves the ground (Figure 4). In some horses, peak extension occurs before lift-off; in others, the joint continues to extend through the early part of the swing phase.

During the swing phase, the hock undergoes about 20 degrees of flexion. This raises the hoof clear of the ground as the hip flexes to protract the limb. Peak hock flexion occurs in the middle of the swing phase, after which the hock extends and lowers the hoof to the ground. We like to see a lot of hock flexion during the swing phase, and the hind limb should be carried forward with the hock in a flexed position, rather than being flexed quickly and extended prematurely.

The front view of the talus (Figure 2, page 17) shows that the trochlea is set at an angle to the long axis of the limb; as a result, when the hock flexes, the lower part of the cannon bone also swings outward (abducts). This mechanism helps prevent the horse from interfering, particularly during the racing gaits when the hind hooves pass outside the front limbs as they swing forward. We have also detected a small amount of sliding motion between the distal tarsal bones.

Early Signs of Lameness

Horses with hock pain modify the motion and weight-bearing of their hind limbs. Our research indicates that horses with mild lameness that is not consistently visible (a grade of 1 or 2 on a five-point scale) show less hock flexion during the stance phase as well as less sliding of the distal tarsal joints.

The vertical ground-reaction force, which measures weight-bearing, is reduced, not only in the lame hind limb but also in the diagonal front limb. In other words, in cases of mild hock lameness, the lame diagonal is unloaded. We were initially surprised to find that there was no compensating increase in weight-bearing by the other diagonal. Instead, there was an overall reduction in weight-bearing forces. The horse accomplishes this by moving with a flatter trajectory, which requires lower ground-reaction forces to lift his body into the air. This is an important finding, as it indicates that horses with mild hock pain that are not yet obviously lame may show a deterioration in gait quality—a flatter, less bouncy stride. These gait changes may be more apparent to the trainer than to the veterinarian, who may not be familiar with the horse's normal (sound) way of going. Under these circumstances, it is useful to have videos that illustrate the subtle changes in quality of movement. ▲

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