Equine Biomechanics and Gait Analysis

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In order to understand a horse's biomechanics and assess its motion and gaits, we first must take a horse's conformation (body structure) into consideration. You can't ask the horse to do something that is physically impossible. To evaluate a horse's conformation for correctness and balance, it must be viewed from the left and right side, as well as from the front and back. A well balanced horse has a better chance of moving efficiently, which results in less stress and lessens the likelihood of injury.

So what do we look for when we assess a horse's conformation (correctness)? First, when viewing the horse from the side, the forehand must be balanced with the hindquarters. When the forehand and hindquarters are balanced, the withers are level or slightly higher than the level of the croup, and the center of gravity is located more toward the rear of the horse. A horse's center of gravity is a theoretical point in its body around which its mass is equally distributed. This point can be found by transecting a vertical line from the highest point of the withers, to the ground, and a horizontal line from point of the shoulder to the point of the buttock (**Fig. 1**).

Most horses must learn to rebalance their center of gravity when moving and when being ridden. How much weight is shifted depends on the horse's conformation, the rider's position, the gait, the degree of collection, and the style of performance. The higher degree of collection, the more the horse steps under the center of gravity with the hind limbs. When the forehand is larger than the hindquarters, a horse's center of gravity tends to be forward.

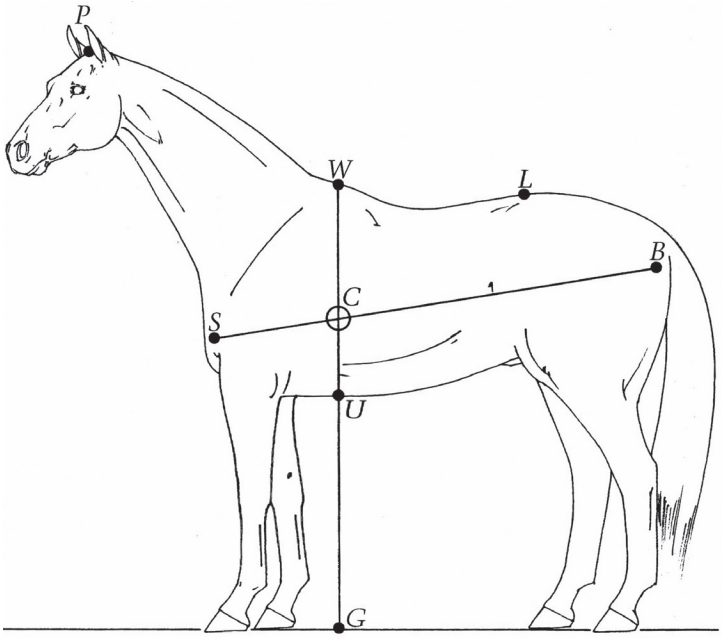

Fig. 2-4. Proportions.
P=poll; W=highest point of the withers; L=loin; B=point of buttock; S=point of shoulder; C=center of gravity; U=underline; G=ground; WU=depth of body; UG=lower limb length; WG=height and overall limb length; SB=length of body; PW=length of neck; WL=length of back; LB=length of hip.
From: Hill, C., Klimesh, R.: Maximum Hoof Power. New York, Macmillan, Publishing, 1994.

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This causes the horse to travel heavily on its front feet. The extra stress on the front end can set the stage for increased concussion to the feet, stress on the tendons, ligaments, and joints, and an increased chance for lameness.

Second, the top line should be smooth, the neck should tie well into the shoulder, and the limb angles should be correct for that breed. Interestingly, a horse's front limbs are not attached to the rest of the spine by a collar bone as are the arms are in humans. Rather, a horse's front limbs are attached to the rest of the skeleton by strong muscles that make up the shoulder "girdle." The nature of this attachment requires the horse to use its long neck to balance the motion that originates when the hindquarters engage.

There are many other characteristics of a horse's conformation that can affect a horse's movement, too. For example, the neck length should be greater or equal to the back length. The hip, from the loin to the point of the buttock, should be at least two thirds the length of the back. If the neck is shorter than the horse's back, a horse tends to have decreased flexibility and a harder time balancing its motion. Longer-backed horses tend to "hollow" out because they have a harder time lifting, and rounding their backs, and moving their hindquarters underneath their center of gravity. Horses with a shorter hip in comparison to the neck or back, tend to lack propulsion/impulsion.

Having assessed the conformation of the horse, let's now turn to the horse's balance. Balanced horses have equal lower limb length and depth of body. You can check this by drawing an imaginary line from the top of the withers to the bottom of the heart girth area. This vertical line should be compared to a line from the point of the elbow to the ground. If the limbs are excessively short, a horse will tend to move with a short, choppy gait. A horse's height (from the point of the withers to the ground) should be compared to the length of the body (from the point of the shoulder to the point of the buttock). If the body length is a great deal longer then its height, a horse may have trouble synchronizing and coordinating movement. Likewise, if a horse's limbs are proportionally longer than its body, the horse may be predisposed to forging or over-reaching, among other gait defects.

Oftentimes, less than perfect movement of a horse is blamed on a poor attitude. You may have found yourself thinking,

or hearing someone else saying, "That Stupid Horse!" However, several things can cause poor movement, such as soreness, lameness, ill-fitting equipment, unbalanced feet, or an unbalanced rider. Modern day technology such as digital video cameras and computers has created an emerging Science of *equine gait analysis*. There are several equine professionals, such as Dr. Hillary Clayton in Minnesota, and Dr. Kevin Keegan in Missouri, who have dedicated their research and careers to equine motion analysis to help the sport horse and the horse enthusiast.

But what can horse owners do to recognize less than perfect movement? It may be difficult for the untrained eye to see unbalanced movement. This is because a horse's stride is often faster than what the human eye can process. If you suspect that your horse may have a developing issue, start by having someone videotape your ride. When you review your tape, you will be amazed at what the camera reveals, especially if you can run it in slow motion.

Early signs of developing lameness issues may include an uneven stride length, hollowed back, stiff shoulders, hollowed neck, or head tossing. Each case must be analyzed individually; however, there are some generalities that one can follow to aid in localizing the source of pain. 65% of lameness in the horse occurs in the front limbs, most of which are due to problems in the front knee (carpus) and below. If the horse is lame enough on the front leg to have a head bob, its head will raise when it lands on the sore front leg. The majority of hind end lamenesses are due to problems in the hock or the stifle. If the horse is sore enough to have a head bob, the head will go down when the horse lands on the sore hind leg. This is so it can transfer more weight to the front end, and alleviate some stress on the sore hind leg. Typically, if the horse is sore in the hock, it will be worse when that hind leg is on the inside of the circle, and a horse with a sore stifle will drag that hind toe more. These again are generalities and each horse needs to be examined individually and thoroughly by a proper professional. Early diagnosis is key to preventing an emerging lameness from developing into a more serious issue.

What constitutes "good movement" is relatively consistent in many respects no matter the breed or equine discipline. When the hindquarters are engaged, the back is rounded and lifted, the shoulders are free, and the head and neck are flexed and quiet. The horse is said to be a good mover. In order to bring out that good movement in a horse, the horse must be conditioned and balanced to use its own conformation optimally, as well as have proper fitting tack and a well-balanced rider. All of this together will also avoid injury to the horse.