Balance Basics

Part 2: Stability

BY HILARY M. CLAYTON, BVMS, PHD, MRCVS

OUR DRESSAGE TESTS BEGIN and end with a halt on the center line. The ideal is a smooth transition to a square halt, with the horse standing immobile and perfectly balanced. You've probably experienced the less-than-ideal halt as well, in which your horse suffers a slight loss of balance. He may even take a small step to the side, losing points from the judge in the process.

You may wonder why such losses of balance happen and whether you can prevent them. In this article, I'll explore the factors that affect the horse's balance and stability when his body is stationary.

Quick Review

In my last article ("Veterinary Connection," December 2004), I described the location of the center of mass (CoM) in both horse and rider and showed how the CoM moves within the body as the position of the head, neck, and limbs changes. In that article, I introduced the following biomechanical terms:

Center of mass (CoM): A point at which the mass of a body is considered to be concentrated, and around which its weight is equal on all opposite sides. Also known as the center of gravity.

Line of gravity: A line that drops vertically from the CoM.

The information in this article is from *The Dynamic Horse: A Biomechanical Guide to Horse Locomotion and Movement* by Hilary M. Clayton. Available from Sport Horse Publications, 3145 Sandhill Road, Mason, MI 48854–1925. Price is $50, plus $3 S&H.

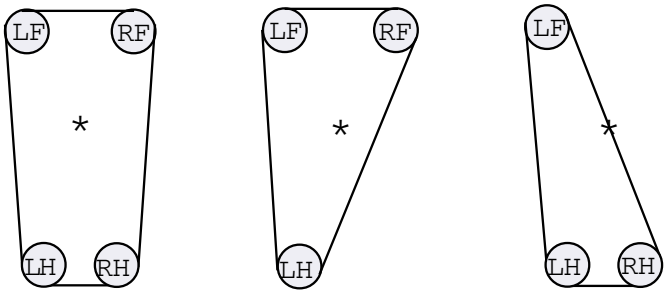

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FIGURE 1. Base of support and location of the center of gravity (*) of a horse standing square (left), with a hind hoof raised (middle), and with a front hoof raised (right). (LF: left front hoof; LH: left hind hoof; RF: right front hoof; RH: right hind hoof.)

Base of support: The area outlined by the points of contact with the ground. When a horse is standing, the points of contact are the hooves that are touching the ground. The perimeter of the base of support is a line connecting the points of contact.

Static Balance

The principles of static balance apply when a horse is stationary. The standing horse is balanced when his CoM is vertically above his base of support, so that the line of gravity contacts the ground within the circumference of the base of support.

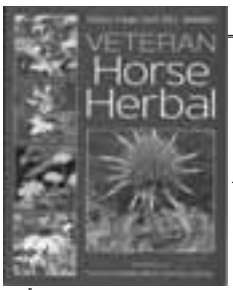
A number of factors affect the stability of a horse's balance, including:

- The size of the base of support
- The location of the line of gravity relative to the periphery of the base of support
- The horse's height and weight.

Let's look at each of these factors in detail.

Size of the base of support. The perimeter of the base of support is defined by the hoof contacts with the ground (Figure 1). The greater the area circumscribed by the base of support, the more stable the balance.

A horse standing squarely has a rectangular base of support. (Figure 1 shows a not-quite-rectangular base of



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support. The exact shape varies, depending on such factors as the width of the horse's chest and the closeness of his hind limbs.)

If one leg is raised, such as when the farrier is working on a foot, only three hooves are in contact with the ground; so the base of support becomes triangular and its area is reduced by approximately one-half, making it more difficult for the horse to stand on three legs.

If the horse has only two hooves on the ground, as in the levade, the base of support is a line connecting these hooves, which leaves very little margin for error in positioning the CoM above the base of support. This is why the horse's balance is so precarious in the levade.

Location of the line of gravity. The more central the CoM's location within the base of support, the greater the stability. In the standing horse, the distance between the front and hind hooves is greater than the distance between the left and right hooves. The CoM is further from the perimeter of the base of support in the longitudinal direction, making the horse more stable longitudinally than laterally. Sometimes we can use this knowledge to our advantage. For example, if a horse balks and resists moving forward, it is easier for the person riding or leading him to initiate movement in a sideways direction rather than forward or backward, as the horse is least stable from side to side. Turning the horse's head and neck to the side further displaces the CoM toward that side, thereby facilitating movement in that direction.

A standing horse can increase his stability by spreading his limbs farther apart to broaden his base of support. This is not something we want to see in the dressage arena, but it may be useful when the horse has difficulty staying balanced during a trailer ride, or in a horse suffering from a neurological disease that interferes with balance. In both of these examples, the horse is likely to stand with his hooves spread wide apart to reduce the risk of falling.

Horse's height and weight. In general, a heavier horse is more stable than his lighter counterpart because it takes more force to displace a heavier body. For horses of equal weight, stability is greater when the CoM is lower (closer to the ground). A lower CoM is more stable because the body must be moved through a larger angle before the line of gravity falls outside the base of support.

These considerations are not particularly important in dressage horses, with the exception of a few special circumstances. The levade (an "air above the ground" in which the horse raises his forehand off the ground to approximately a 45-degree angle, as pictured on the cover of this month's issue) is more stable than the pesade (another "air" similar to the levade, but with the horse's forehand raised considerably higher) because of the lower position of the horse's body and CoM. When a horse spreads his legs during a trailer ride, he is better balanced, not only by virtue of having a wider base of support, but also because he has lowered his CoM slightly.

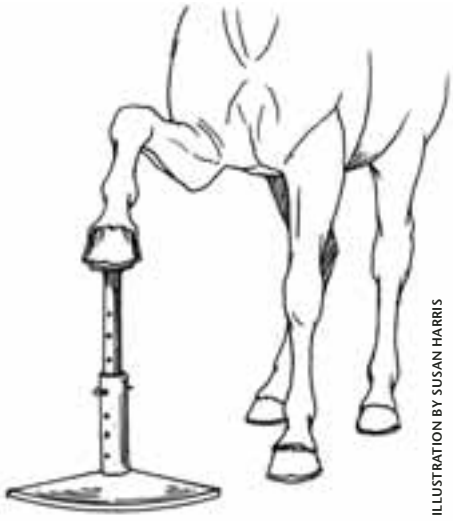

ILLUSTRATION BY SUSAN HARRIS

FIGURE 2. The farrier's stand is designed for stability. It is heavy, with its mass concentrated in the base (low CoM) and its line of gravity contacting the ground centrally within its large round base of support. The hoof support is centered above the base.

The Farrier's Stand

The farrier's stand, used to support the horse's hoof and leg during certain trimming and shoeing tasks, exemplifies design features consistent with the need for stability (Figure 2). The stand is heavy (large mass), with the mass concentrated in the base (low CoM) and the line of gravity contacting the ground centrally within the large, round base of support. The hoof support is centered above the base, and the horse must exert a large horizontal force to displace the top of the stand. Even if the stand is tilted, it tends to return to its original position when the tilting force is removed. The stand can be displaced quite far in any direction before the line of gravity contacts the ground outside the base of support and it falls over.

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Maneuverability

We have looked at factors that increase the stability of static balance, but it is also important to realize that there is a trade-off between balance and maneuverability, or the ability to initiate movement rapidly in any direction. Maneuverability is enhanced when the CoM is located close to the periphery of the base of support, thereby facilitating movement in that direction. Equestrian sports that require the ability to change speed or direction rapidly, such as cutting, require maneuverability.

Conformation and Stability

In the animal kingdom, some species are adapted for stability, while others show conformational features consistent with the need for maneuverability. The most stable animals are those that have short legs and heavy bodies, with the CoM placed centrally within a large base of support, such as the rhinoceros. The combination of long legs and a slender body, as in the gazelle, increases maneuverability.

Horses occupy an intermediate position on this scale, with conformational features adapted for both balance and maneuverability. Within the horse world, differences among breeds make individuals more or less suitable for various sports or occupations. For instance, a draft horse has a large mass, short legs, and a broad base of support in relation to its height—features that favor stability at the expense of maneuverability. In comparison, a Thoroughbred is lighter in weight, taller in relation to his mass, and has a relatively narrow base of support.

Even within the same breed, different bloodlines may be adapted for certain sports or activities. In the Quarter Horse breed, for example, sports that rely on stability (e.g., roping) favor a heavier horse with a broad base of support; whereas sports that require more

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maneuverability (e.g., cutting) require a less-massive animal with a relatively narrow base of support.

Balance Skills

Stability is particularly important in balance skills that require a position to be maintained with a small base of support. An everyday example of a balance skill that we require of our horses is picking up a foot and standing with a triangular base of support. Figure 1 shows that if a hind hoof is raised, the horse's CoM is still within the support triangle but is closer to the periphery than when he stands on all four limbs. Consequently, his balance is more precarious than when all four hooves are on the ground. In contrast, when a front hoof is raised, the line of gravity falls so close to the edge of the base of support that the CoM must be shifted sideways or backward to keep it safely within the perimeter and thereby maintain the horse's balance. The horse achieves this by leaning sideways, backward, or both, away from the front hoof that will be lifted. This need to shift the CoM before raising a front hoof explains why it is easier for a horse to pick up a hind limb than a front limb.

In the most difficult balance skills, the athlete must maintain static balance in an unusual position that has a very small base of support. Horses aren't able to emulate the incredible feats exhibited by gymnasts on the balance beam; but *haute école* airs, such as the levade, require very good balance on the part of horse and rider to position the CoM vertically above the line joining the hind hooves (Figure 3). The lower position of the CoM makes the levade more stable than the pesade.

ILLUSTRATION BY SUSAN HARRIS

FIGURE 3. The horse's base of support in the levade is shown by the gray line between the two hind limbs.

To execute balance skills effectively, the horse must develop adequate strength to support his body in the required position, together with the ability to shift his body weight quickly into the correct position at the right time. If his CoM moves outside his base of support, he must make a quick adjustment in order to regain his balance. He does

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this by changing or enlarging his base of support to encompass the CoM or by repositioning his hooves so the CoM is inside the base of support. If the CoM has been allowed to move too far outside the base of support, or if too much falling speed has developed, he may not be able to regain his balance.

In the levade, the horse maintains his balance by using the muscles in his back and his hind limbs to maintain the elevation of his forehand. These muscles overcome the forehand's tendency to fall forward and descend to the ground, thus ending the levade.

Loss of Balance

What happens if the CoM moves outside the base of support? Because the conditions for static balance are no longer fulfilled, the horse falls toward the CoM until he makes a new contact with the ground or other rigid surface, allowing him to reestablish a balanced position. You've probably noticed that, on occasion, when you pick up one of your horse's feet, he becomes unbalanced and lists toward you. Your choices when this happens are to allow him to put the foot down to recover his own balance, to support some of his weight by acting as a fourth leg, or to risk the consequences of his losing his balance and falling in your direction.

Resisting Displacement

If a standing horse is pushed or bumped with sufficient force, the CoM may be displaced far enough that the line of gravity falls outside the base of support and the horse loses his balance. If the horse anticipates the action of a force that will push him off balance, he can counter the disruptive effect by leaning into the force. A horse resists stepping away from pressure on his side by leaning toward you as you push against him. When you mount a horse from the ground, he is sometimes

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caught off balance and staggers to his left as the stirrup is weighted. He learns to brace his body against the force on the left stirrup to avoid being pulled off balance. Habitual bracing during mounting leads to asymmetrical muscle development, which can be avoided by using a high mounting block or accepting a leg up. Another option is to have a helper exert pressure on the right stirrup as you mount, which helps to stabilize both saddle and horse.

The Halt

I began this article with a discussion of the horse's balance as you halt at X. You, the rider, are responsible for preparing your horse for the halt and for indicating to him where he is to halt. You should allow him to complete the halt and establish his balance before you salute the judge. Your horse balances as he halts by pushing his hooves against the ground in the appropriate direction to slow the forward motion and then to centralize the position of his CoM. These adjustments are the source of the instability you may feel as the halt is established.

A common rider mistake is to be in too much of a hurry to salute, so the horse never settles into a balanced halt and may move a leg to improve his balance rather than pushing against the ground to adjust the position of his CoM. Your position affects your horse's balance in the halt, so sit in the middle of the horse and resist any tendency to tip forward or sideways as he stops. Then wait quietly until he feels completely still and balanced before you take the reins in one hand.

As an aside, several years ago, I timed the halts at the beginning and end of a Grand Prix dressage test. The average duration of the halt at the start of the test was seven seconds, compared with just four seconds for the final halt. The riders were apparently in a hurry to get out of the arena!

Keep in mind that horses competing at the FEI levels are generally adept at organizing their balance in the halt. Less-experienced horses may need more time and a little extra help to achieve that perfect halt, so avoid the temptation to get it over with as quickly as possible.

The third and final article in this series on equine balance will evaluate balance during locomotion, which is very different from static balance. ▲

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