THE ESSENTIAL HOOF BOOK
Susan Kauffmann and Christina Cline with a Foreword by Gene Ovnicek
Anatomy, Care and Health, Disease Diagnosis and Treatment

What's inside? Key concepts, easy-to-follow language, 400 full-color photographs, and hands-on activities. Whether you are a horse owner, equestrian competitor, or hoof-care professional, whether you are new to the realm of equine health or educated and experienced, these are the tools you need to accurately assess the hoof and keep your horses sound and happy.

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Nature loves symmetry. Symmetry indicates balance, and balance encourages good biomechanics. Developing an eye for symmetry and balance is definitely helpful in identifying hoof problems, though healthy hooves often show some minor asymmetries that are quite normal.

Normal Asymmetries

**Medial vs. Lateral**
If you draw a line down the middle of the sole from back to front, then compare the two halves, you want to see that the medial and lateral halves match fairly closely. But, even in a well conformed, good moving, and properly balanced horse, you will often find that the lateral half of the hoof is a smidge wider than the medial half (fig. 7.1). Similarly, peer closely at the medial and lateral walls when the horse is standing on a level surface, and you will probably see that the medial wall is slightly more upright than the lateral one.

Both of these minor asymmetries happen because the inside half of the foot is designed to bear a little more of the weight of the horse than the outside half does, while the outside half plays a larger role in stabilizing the foot. The slightly steeper angle of the medial wall allows it to deal with the greater forces it encounters, but it also makes the inside half of the foot a little narrower than the outside half.

**Front vs. Hind Feet**
Another place where it is normal to see asymmetry is when you are comparing the shape of the front feet to the shape of the hind. Viewed from the bottom, healthy front hooves will usually be fairly round while the hind will be more oval-shaped or narrow.
The front feet on most horses are rounder (left) than the hind (right), which can be oval shaped, like this one, or sometimes a little more triangular.

a bit more pointed at the toe (fig. 7.2). Viewed from the side, the dorsal wall (front surface) and heel angles of the front will commonly be slightly shallower than those of the hind (fig. 7.3). The front feet are also typically larger than the hind, often a full size when it comes to shoes or hoof boots.

The fact that the hind feet are more upright might seem surprising given that we just said steeper walls reflect greater load-bearing capacity, and you’ve probably heard that horses bear more of their weight on the front limbs. But, while it is true that a standing horse carries more of his weight on his front feet, a moving horse shifts his weight back, where the hind feet to do the heavy work of pushing and carrying. The hind feet, therefore, need to be up to the task of more intense loading than what the front feet experience, which is reflected in the angles of the pasterns and hoof walls.

Left vs. Right Asymmetries: High/Low Syndrome

In a perfect world, the shape, size, and angles of your horse’s left front foot would be identical to those of the right front foot, and the hind feet would also match one another. In the real world, the pairs should still be quite similar, but slight differences are always present, especially in the front. However, minor differences do not make a horse’s feet “mismatched,” it merely makes them a realistic reflection of the fact that no animal as large and complex as a horse can exhibit perfect symmetry.

Horses can have any number of variances that will make one foot a little different than the other, but the most commonly encountered is that one front foot will be slightly more upright than the other. This difference is often due to the fact that horses, like people, tend to have a dominant side.
Left to their own devices, most horses prefer one canter lead over the other, and most will also habitually graze with a particular front foot forward more often than the other.

Over time, these preferences can change the shape of the feet, with the “forward” foot developing a lower angle, as it is bearing more weight toward the heel, and the “back” one becoming more upright (fig. 7.4), as it is bearing more weight toward the toe. The low-heeled foot is typically the more dominant side, which affects not only the feet, but the entire body. This is often noticeable as heavier muscling in the dominant shoulder, which is easiest to see when you stand above and behind your horse. A majority of horses are left-side dominant (fig. 7.5).

In most cases, if the difference between the angles of your horse's front feet is hard to notice unless you are really looking for it, it is probably not worth worrying about, though you may want to check it now and again to make sure it is not getting worse. A safe bet is that if the difference is less than 5 degrees, it is likely not causing issues for the horse, although most horses are more supple on their dominant (low foot) side. Riders can often

7.4 This mare prefers to have her right foot forward when she grazes, and if you look closely, you can see that it has a slightly lower angle than her left. Such differences are very common in horses with distinct “handedness.”

7.5 Even with the heavy mane on the right, you can see that there is more muscle mass on the left shoulder of this horse. Such uneven muscling is an extremely common finding in horses and usually correlates with a slightly lower angled foot on the same side.
feel this in their horse, as the horse will be easier to bend toward the low-footed side and will probably prefer to canter in that direction, as well. If your horse is like this, it would likely be beneficial to his overall balance and musculoskeletal health to work on strengthening and suppling the weaker side, though this may not have any noticeable effect on his feet.

If you are seeing a marked difference in the angles of your horse’s hooves, you could be looking at high/low syndrome, an issue where one foot is significantly more upright than the other, and the lower-angled foot is usually larger than its partner (fig. 7.6). High/low syndrome can be hereditary (such as a club foot), acquired through a postural habit like the classic foal grazing stance, injury related, a result of unbalanced riding and training, a saddle-fit issue, or a byproduct of any number of aches, pains, subluxations, dental issues, or other problems you may never discover.

High/low syndrome is another one of those chicken-and-egg scenarios in which you have to unravel the problem of, “Which came first?” On the one hand, a difference in the feet can cause other parts of the body to compensate for the imbalance, creating a cascade of problems such as muscle pain and stiffness, twisting of the vertebrae in the neck and spine, uneven muscle development in the shoulders and back, saddle-fit issues, and much more. On the other hand, various problems in other parts of the body can cause postural changes that affect the feet, and may be the cause of the high/low feet. Either way, careful and thorough assessment is in order.

Addressing the feet of a horse with high/low syndrome can also be a challenge. The first step is determining which foot is the primary one you want to change. To do this, you need to figure out if the low foot is closer to normal in terms of the hoof-pastern axis, in which case, the task will be to try to lower the angle of the more upright one. If the more upright one has healthier angles, the focus will be on trying to get the low-angle foot to stand more upright.

When you are working on high/low feet, it is important to recognize that high/low syndrome cannot always be “cured,” and will thus require ongoing management. A lot depends on how long the high/low syndrome has been going on and how early it started, which will determine whether or not the two front coffin bones are entirely different shapes and sizes. If they are significantly different,
the chances of making the two feet match are about the same as winning the lottery. However, if the bones are the same size and shape, chances of regaining symmetry are significantly better, as long as the causative body imbalances are taken care of. Bodywork, stretching, and exercising to minimize muscular imbalances are all helpful in giving your horse’s high/low feet the best chance to improve.

You must also keep in mind that while changes in trimming can sometimes minimize the differences in high/low feet, you have to be sure this creates a positive functional change, and not just an aesthetic one, as it is very possible to force a foot to look more like we think it should, but actually make it functionally worse. This is especially true with club feet.

**Club Feet**

Some cases of high/low feet involve a *club foot*, which is an upright foot caused by a shortening of the tendon and muscle of the deep digital flexor unit. The excessive pull on the DDFT turns the coffin bone downward, loading shifts to the toe area, and the hoof changes shape in response. The classic club foot is upright and contracted, and there may be a “fullness” in the coronet area due to the forward displacement of the extensor process of the coffin bone and the second phalanx just above it. The hoof wall will often show rippling and dishing in the front, and wider growth rings in the heels. However, club feet can vary quite a bit in appearance, and what they look like depends in part on the severity of the problem, and to a degree on the quality and timing of the hoof care they receive.

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7.7 A–D  Dr. Redden’s Club Foot Classification.

**Grade 1 (A):** The hoof angle is 3–5 degrees greater than the opposing foot and a characteristic fullness is present at the coronary band due to subluxation (misalignment or partial dislocation) of P2 (short pastern bone) and P3 (coffin bone).

**Grade 2 (B):** The hoof angle is 5–8 degrees greater than the opposing foot with growth rings wider at the heel than at the toe. Heel will not touch the ground when trimmed to normal length.

**Grade 3 (C):** The anterior hoof wall is dished and growth rings at the heel are twice as wide as on the toe. Radiographically, P3 exhibits demineralization and lipping along the front of the bottom edge.

**Grade 4 (D):** The anterior hoof wall is heavily dished and the angle is 80 degrees or more. The coronary band is as high at the heel as at the toe, and the sole is below the ground surface of the wall. Radiographically, P3 is rounded due to extensive demineralization, and rotation may be present.

Club feet are graded on a scale of 1–4, with “1” being a mild case that may be hardly noticeable and “4” being severe (figs. 7.7 A–D). Higher grade cases may have limitations in terms of their ability to perform and to remain sound, but the majority
of horses with lower grade club feet are able to lead quite normal lives with appropriate hoof care, and owners of grade 1 horses may not even realize that their horse has a club foot at all. Some horses with club feet have even been successful in high-level competition.

If your horse has a mild club foot that does not appear to be getting worse, it is something to be aware of and keep an eye on, but it is not a reason to panic. A competent hoof-care provider will know how to manage such a foot—most often by simply keeping the feet balanced and not worrying about trying to make them “match.” Caring for a horse with a significant club foot (grade 2 or higher) is more challenging because such a horse is at higher risk for a variety of problems. The altered biomechanics of a club hoof can not only affect that foot, but also the limb, the other feet, and the rest of the body, which must compensate for the changes. As with feet that are mismatched for any reason, massage, chiropractic work, regular dental care, expert saddle fitting, and skilled riding exercises can be very helpful in keeping a club-footed horse sound and performing at his best.

Many of the problems that can be brought on by a club foot stem from the fact that the tightness of the DDFT is continually pulling the coffin bone around on its articular axis, causing the foot to want to land toe first. This puts an abnormal amount of pressure on the toe area while taking weight off the heel. Depending on the severity of the condition, the dorsal wall may ripple and dish in response to the increased loading, an issue that can be further compounded if the extensor process is pressing into the coronary corium, which can compromise blood flow and inhibit growth of the dorsal wall. When this happens, the heels still have an adequate blood supply and therefore grow at a faster rate than the toe.

But the possibilities for problems don’t end there. If the club foot is putting excessive pressure on the toe, this can lead to inflammation of the laminae, white line separation and subsequent white line disease, and also make the front of the foot more vulnerable to cracks, bruising, and abscessing. Abnormal loading of the joints may cause osteoarthritis, and over time, the tip of the coffin bone can become deformed, demineralized, and may even fracture (fig. 7.8). And, if the coffin bone is displaced enough for that to happen, you can be sure there is some compression of the solar corium, which affects circulation and sole growth in the toe area.

7.8 In addition to affecting what a hoof looks like on the outside, a club foot can cause profound changes inside the foot as well. The coffin bone of this grade 4 club foot already shows abnormalities, and this is only likely to get worse over time. Says Dr. Redden, “In grade 4 feet, the bone remodels quickly and shows signs of extensive bone resorption and remodeling, often appearing as a rounded off, very misshapen surface, indicating a large area of apex has been resorbed.”
Recognizing Low-Grade Club Feet in Foals

Foal feet have a different shape than what we are used to looking at in adult horses, tending to be more upright and relatively tubular, as they have not spread out yet from years of weight bearing. Because of this, it can be difficult to recognize a low-grade club foot in a foal. If you know what to look for, however, the differences, subtle though they can be, will be easier to spot. Trying to note differences in the dorsal wall angles can be tough, as even a 5-degree disparity is hard to see without whipping out a protractor and taking actual measurements—not always the easiest thing to do with a bouncing baby horse.

However, there will also be differences in the heel angles, and sometimes, these are more obvious. The next clue you might be able to discern is that the feet will bear weight differently. The club foot will tend to weight the toe more than the heel, and the heel may even lift a bit off the ground. The opposite foot will load flat or with more weight on the heel (fig. 7.9).

Learning to see subtle differences in your foal’s feet might just help you spot a problem early, which is the best way to keep any hoof issues from becoming life-long problems for the horse. Try to observe your foal’s hooves on a regular basis, as they can change quite quickly when the foal goes through growth spurts. If you think you see something that could be a concern, don’t hesitate to call your vet. Better to have the doc come out and tell you it is nothing, than miss what could be your best chance to help the foal.

7.9 These are the two front feet of a young foal. Subtle clues show you that the white foot is a Grade 1 club. The minor difference in the dorsal-wall angle is hard to see, but the difference in the heel angle is more apparent. You can also see that the white foot is lifting up slightly in back, while the black foot is rooted in the heels. Lastly, the dorsal wall of the white hoof lines up very directly under the lower front of the pastern, giving that part of the pastern a “full” appearance (yellow arrow). This is due to the coffin bone rotating and the coffin joint pressing forward. The lower front of the black pastern, in comparison, has a little more of a “dish” to it (blue arrow).
This is why the sole in the toe region of horses with club feet is often painfully thin.

More issues can crop up in the back of the foot, as the heels typically contract in a club foot, causing the frog to recede and rendering the foot even less able to dissipate concussion. This, in turn, puts a greater amount of pressure on the already stressed toe and coffin bone, creating the potential for a really vicious circle of dysfunction. Then there is the navicular bone, which can also be affected by the increased pull of the DDFT. It is not unusual to see changes in the navicular bone quite early in horses with club feet.

In addition, the altered function of a significant club foot will almost always cause changes in other feet as well. Typically, the foot opposite the club, as well as the one behind it, will have a tendency to develop long toes and low heels, which bring their own set of problems to those feet. Frequently, the “low” feet will start having issues before any are noted in the club foot.

Because there are so many possible effects from a club foot, good management is absolutely critical. If recognized early enough—when a foal is born or very young—a club foot can often be corrected to the point where it will have little to no effect on the horse's long-term potential to remain sound. Early treatment involves corrective hoof care, sometimes in combination with surgery to relieve tension on the DDFT, all aimed at enabling the foot to load and grow more normally.

In an adult horse, the degree to which a club foot can be managed depends on a number of factors, including how bad it is, what caused it, and how long it has been that way. In long-standing cases, or any case where significant damage to the bones and soft tissue has already occurred, the potential for improvement may be limited, but an expert will be able to manage the foot to get it functioning as best it can and minimize problems (fig. 7.10). The Equine Lameness Prevention Organization (ELPO), co-founded by Gene Ovnicek, has specific guidelines that can help hoof-care professionals manage club feet and mismatched feet optimally.

Some adult horses may also be good candidates for a surgical procedure often used on foals, in which the inferior check ligament of the DDFT is cut, thereby lessening the tension that is causing the club foot. There is also another surgery called a deep digital flexor tenotomy (see p. 203), which is performed higher up the leg and may be a solution for grade 4 cases and grade 3s that have been unresponsive to other treatments.

Unfortunately, it is very easy to make a club foot worse with what might seem like the most logical thing to do—lowering the heels. While lowering the heels might indeed be called for, it has to be done...
with extreme care and with full understanding of
the physiology and biomechanics of the structures
involved. Far too often, well-meaning hoof-care
providers will lower the heels too much, too soon,
or without taking other critical measures, the result
being that they cause the deep digital flexor appa-
ratus to tighten more in response to the increased
tension placed on it by the “missing” heel, and the
foot may get tipped farther forward as a result. Club
feet that have had too much heel removed (and
sometimes even a little is too much) can end up with
the heels literally hanging in the air (fig. 7.11). This is
likely to make the horse sore, and could potentially
cause serious harm.

In order to have any chance of truly improving a
club foot, the key is easing the tension on the DDFT,
which can often be at least partially accomplished
by moving the point of breakover back. This may
appear counterintuitive for a foot that already wants
to “knuckle over,” but if you don’t help the foot get
some slack into the DDFT, it will continue to pull
itself in the wrong direction. The idea of facilitating
breakover makes more sense when you realize that
easing the pull on the DDFT is really the only way to
ease the pull of the DDFT.

An apparent lack of understanding of this
very important piece of the puzzle has led some
hoof-care providers to try to correct a club foot by
lowering the heels and then either leaving the toe
long, or sometimes putting on a shoe that extends
the toe beyond the front wall. While this may be a
reasonable plan in certain cases involving young
foals or immediately after check ligament surgery, it
is counterproductive for an adult horse, unless it is
a post-surgical measure to help realign the bones of
the foot.

7.11 This miniature mare had severe club feet, as you can see in
the upper photo. Though it went against his better judgment, the
farrier followed the owner’s request to remove a large amount of
heel in one trim. The result (lower photo) was that the feet were
left standing “en pointe” like a ballerina, with the heels up in the
air. Her heels did sink down over time, and she did not appear
to suffer any trauma. However, in a larger, heavier horse, the
enormous strain such drastic trimming would cause could lead to
severe injury.
A toe (or shoe extension) that puts the point of breakover too far ahead of the tip of the coffin bone increases leverage on the already stressed laminae, and if you combine this with extra DDFT tension from lowering the heels, you will greatly increase the chances of the coffin bone tearing away from the hoof wall and rotating inside the hoof capsule. Even when used in foals, toe-extension shoes must be employed with great care, as they can cause other problems if left on for too long (fig. 7.12).

As for how club feet get to be that way in the first place, there are several possibilities. Some cases likely have a genetic component, as certain blood lines seem to produce more individuals with club feet than is typical. Most club feet start very early in the horse's life, either as a congenital limb deformity already present at birth, or as an apparently acquired limb deformity that develops as a result of the foal's tendons and bones growing out of sync. However, it is possible that some of the supposedly acquired cases already had the problem brewing when they were born, and it simply went unrecognized or was not manifesting observable signs at that time.

7.12 The toe-extension shoe used on this foal was glued on and was very difficult to remove. It was then left on far too long, causing the foot to become contracted, as you can see by the narrow, deep central sulcus (red arrow) and close-together heels (yellow bracket). The foot's dorsopalmar balance was also affected, causing there to be more ground-contact surface in front of the widest part of the foot (green line) than behind it. This would be more obvious if the photo showed the foot straight from the bottom, rather than foreshortened.
Many experts now believe there may also be a nutritional factor in some cases of club feet, citing overfeeding of nutrients and excessive caloric intake as the root problem (fig. 7.13). The thinking is that the too-rich diet causes developmental orthopedic disorders (DOD), and the pain from these problems leads to abnormal loading of one or more limbs, which then gets the club-foot ball rolling. Adult horses can also develop a club foot as a result of pain or injury that causes alterations in the loading patterns on their feet.

However they get started, club feet are best managed by competent, experienced hoof-care providers who understand when and how changes should be made, and when to leave well enough alone. The horse also needs an owner that pays attention, looking for any changes in the feet or the way the horse is going, and who is not afraid to ask questions or even seek out a different hoof-care provider if the foot is deteriorating. There are certainly cases where even the best professionals will not be able to alleviate the problems of a horse with a club foot, but if your horse takes a turn for the worse when changes are attempted, it may be that the methods being used do not suit your horse’s needs.

Mediolateral Imbalance (aka Medial-Lateral Imbalance)

Another important type of asymmetry you want to keep an eye out for is mediolateral imbalance, which as mentioned earlier, is the term used to describe anything beyond minor asymmetry in the two halves of an individual foot. Mediolateral imbalance will be noticeable from one or more angles (fig. 7.14):
Treating the Club Foot

R. F. Redden, DVM, provides the following advice for treating club feet:

“The key to treating the club foot is best referred to as management, as the genetic code regulates the firing mechanism on the muscle and we are left to minimize the ill effects with two basic treatment concepts:

1) Attempt to improve the overall shape of the foot by removing the excessive heel growth and dish. This traditional concept offers temporary cosmetic appeal but invariably increases the tension on the musculo/tendon unit and associated components. Resisting the same force that caused the hoof distortion can be counterproductive.

2) We can reduce the tension that the muscle is exerting on the tendon, bone, and associated components, thereby enhancing the blood supply to compromised growth centers and ultimately improving the cosmetic appearance as well as soundness.

“The tension-reducing concept has advantages and fewer ill side effects, as it aids growth of the sole and the toe horn tubules, and can prevent hoof and bone distortion. Early detection of the effects of the increased suspension, and timely, efficient treatment can greatly enhance the overall appearance and soundness of the foot. Without appropriate management, the month-old foal with a slightly higher hoof angle may progress quickly to a grade 2 or 3, or it may remain a low grade that will become more noticeable as the opposite foot develops a lower profile. The same applies to older horses.

“If you address the problem early, it may be that maintaining the foot with appropriate trimming is all that is necessary to reduce the slight suspension increase and prevent the foot from progressing to a higher grade. A foot that remains a grade 1 club throughout the life of the horse can be easily maintained as long as it is trimmed and/or shod in a fashion that does not drastically reduce palmar/plantar angle and thereby increase tension on the DDFT. Dropping the palmar/plantar angle of the club foot with every trim to match the opposite foot invariably increases tension on all structures and will slowly remodel the face of P3, the lamellar zone, sole depth, and articular surface.

“Good management of any club foot demands that you stay alert to the response and adjust treatment accordingly. If it becomes apparent that trimming alone or standard shoeing is allowing the foot to progress to a higher grade, therapeutic shoeing or surgery may be necessary. Whatever methods are used, it is very important that the elected treatment prevents excessive bone remodeling and horn growth center damage.

“In addition, it is extremely important to pay attention to any changes in the lower profile feet. The grade 1 and low grade 2 club feet are considered strong, healthy feet by most horsemen’s standards, and rightly so, as they have an exceptionally strong heel and, as a rule, adequate mass (fig. 7.15). However, it is the opposite foot and the hind foot behind the apparently stronger club foot that confirm the club syndrome, and it is these lower profile feet that pose a threat to soundness...
• From the front, the foot may be taller on one side than the other, with the hairline slanting upward, toward the taller side. The wall may have a markedly different angle on one side, sometimes due to flaring (see Flares, p. 99).

• From the bottom, the medial and lateral sides of the hoof may be quite different in width and shape. This is sometimes due to flaring.

• From the back, one heel may be wider than the other, or one may be pushed up higher than the other (sheared heels—see p. 73).

Like other forms of asymmetry, mediolateral imbalance can be a symptom of a variety of possible problems such as unbalanced trimming/shoeing or conformational faults, but it always relates to uneven loading of the hoof. It is the uneven loading that can damage the foot, as well as other parts of the limb. Problems associated with mediolateral imbalance include flaring, bone remodeling, joint pain, inflammation, arthritis, sidebone, ringbone, and tendon/ligament strain.

Dorsopalmar (or Dorsoplantar) Imbalance

In addition to seeing how the left and right halves of the foot are balanced, you also want to evaluate the hoof's front-to-back balance. We call this dorsopalmar balance when we're talking about the front foot, and dorsoplantar balance when we're talking about the hind. You may also see the term anterior/posterior balance, which is the same for both front and hind feet. Farriers and veterinarians may refer to this in shorthand as “DP balance” or “AP balance.”
What you ideally want to see is a foot with approximately $\frac{2}{3}$ of its mass in the back of the foot, behind the true apex of the frog (usually located about $\frac{1}{2}$ inch behind the front point of the frog), and $\frac{1}{3}$ ahead of the apex. This also equates to a foot that has about 50% of its mass both ahead and behind the axis of rotation of the coffin bone, a point which corresponds to the widest part of the foot (fig. 7.16). A foot with these general proportions accomplishes two very important things. First, the foot will have a strong base of support, with the hoof set up well under the bony column of the leg, maximizing the hoof’s ability to bear weight and dissipate impact forces. Second, good DP balance

Hands-On Activity: Examine Your Horse for DP Balance

To check out your horse’s feet for front-to-back balance, find the widest point of the foot, then draw a line across it with a marker. Next, measure from that line to the very back point of the heels that touch the ground and jot that measurement down. Lastly, measure from the line forward to the point of breakover (POB), which is the most forward point where the hoof would contact the ground if standing on a flat surface (see Understanding Breakover, p. 95). If there is any bevel in the shoe or toe, the POB is the spot where the bevel starts (fig. 7.17).

Now compare your measurements. If you find that your horse has more mass in the front part of the foot, talk to your hoof-care provider about it. If he or she is not concerned, it might be advisable to get a second opinion from another provider or your veterinarian. Repeat this exercise on all four feet. You can also use your measurements to compare the left front to the right front, and the left hind to the right hind. Note any disparities and discuss them with your hoof-care provider as well.

7.16 The foot on the left has poor dorsopalmer balance (DP), with much more mass ahead of the widest part of the foot (blue line) than behind it (green line). The foot on the right has nearly perfect DP balance. Note that the point of breakover on the right foot is where the bevel on the shoe sits.

7.17 Master Farrier Gene Ovnicek shows you how to examine dorsopalmar/dorso-plantar balance (DP). This foot is prepared for the application of a shoe that has a bevel to facilitate breakover, so Ovnicek has drawn the front line where the point of breakover (POB) on the shoe will be.