FARRIERY
FOR BIOMECHANICAL SYMMETRY
AND NORMAL FUNCTION

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ABSTRACT

Foot function and balance have a profound influence on posture, proprioception and physiologic function. This presentation gives practical guidelines for determining appropriate hoof balance and demonstrates the neurologic and biomechanical significance of that balance.

INTRODUCTION

I would like to thank all the farriers who have provided some of the theoretical and practical background for this work, as well as all those who have worked with me – including Dave Duckett, Dean Pearson, Martin Kenny, Jack Phoebus, Per Jensen, Mark Agostinelli, and Steve Teichman.

Correct shoeing is the ***key*** to long-term success of the application of many therapies and modalities of treatment for lameness and to the maintenance of soundness.

Two things are not going to change in the management of lameness - gravity and fifty five million years of the horse's biomechanical and neurological evolution. If we inappropriately manipulate the feet, which are the interface between these two forces, we will have trouble. In this manipulation lies the ultimate cause, and cure of many lameness problems.

The way we can effect the most rapid recovery is to radically go back to nature's design. Nature has a plan for dealing with lameness through hoof changes over time. In the process of lameness, there is a pattern of recovery and rebalancing. We often arrest this process for the sake of arbitrary cosmetic appearance and an unnatural hoof or shoe interface with the ground that fits into traditional mechanical shoeing convention. This is ***not*** how the foot functions dynamically or how it interacts with the horse's nervous system. We have a responsibility to protect the foot, but not to change the working surface or dynamic function that nature would provide in an environment that is consistent with the evolutionary design of the horse and with the age, the development of the animal, or the stage of healing from an injury.

Uneven feet, if left alone in a rough environment, will rapidly become biomechanically symmetrical, but not necessarily cosmetically symmetrical. Initially, in the process of recovery from lameness or uneven weight bearing, the horse may be uncomfortable, and his feet will break and change, but this is a ***normal*** part of the process. We must not interfere with the normal change, in fact we must encourage it. We can, however, intervene to minimize pain, keep the horse in work, reduce foot damage, and return to optimal function more rapidly.

Neutral and natural stance, posture, and normal gait initiation in daily maintenance movements are the most important influences on the horse's biomechanical and physiologic balance. Sleeping, feeding, and walking are the majority of horses' activities, no matter how hard they are training. These activities program the nervous system and stress the structures constantly. Bones, tendons, and ligaments in maintenance, growth, and healing respond to these stresses more than to training stresses. The combination of training and postural stress may be more than the system can handle if they are not managed appropriately, or are at cross-purposes to each other.

The mechanisms that establish static posture and guard against excess in movement include stretch receptors and length evaluators in muscles, tendons, and ligaments. These mechanisms are a complex system of checks and balances that must stay properly balanced in relationship with each other. Shoeing and temporomandibular joint (TMJ) input have the greatest influence on these structures and the nervous system, as they are the major interface and balancers of the whole system with gravity.

Delay to normal breakover is the ***major*** cause of long term postural imbalance as well as many chronic joint problems. "Goat-on-a-rock" stance (see Figure 1 - *Goat-On-Rock Posture*) created by front foot breakover delay, causes most of our common lameness problems. The body recognizes delay to breakover as an upward incline of the ground surface and will alter the balance of the body to accommodate for the perceived change. The horse leans up the "incline" registered by his long front toes and loads his hind legs excessively, creating the "goat-on-a-rock" posture even on a flat surface. The majority of chronic lameness is a function of inappropriate joint, tendon, and ligament loading caused by this postural defect and its variations. Posturally inaccurate tension challenge of the flexors of the front legs creates increasing flexor tone leading to contracture, pain, foot pathology, and spinal change. Lateral asymmetry of the body is often maintained long after lameness is resolved by not allowing biomechanical foot symmetry to be reestablished. This can lead to eventual change in all other balance mechanisms, including the TMJ and spinal joint receptors. One cannot stop the progression of chronic lameness and asymmetry without addressing postural and weight bearing asymmetry created by simple biomechanical asymmetry of the feet, as nature would.

BASIC FORMULA FOR RETURNING TO NEUTRAL STANCE AND EVEN WEIGHT BEARING

BRINGING BREAKOVER BACK

To place the weight bearing surface where the nervous system can interact with it as nature intended, we can minimally shorten the toe at the front "pillar" area and set the shoe back to bring the breakover to the perpendicular projection of the tip of the coffin bone. (See Figure 2 - *Leverage & the Natural Foot*) If the horse were barefoot, a sole callous would form here from weight bearing, and wear of the wall would keep the toe short and completely rolled. Shortening the wall too much at the "pillars" in a thin-soled foot can cause severe toe and sole pain as stance change occurs and the horse loads his front feet more heavily before the sole thickens.

Most horses have damage in the laminae, due to toe leverage over time. Damage also occurs at the coronary band and the white line is stretched from excessive leverage of the wall. More natural weight bearing through the frog and sole pack can be used to minimize the use of leveraged wall and allow pathology to resolve. The toe wall can be slightly boxed to avoid interference with breakover. Dressing the hoof wall to meet the set back shoe can weaken it and cause it to flex excessively during the change process causing shearing and pain. Excessive hoof leverage exacerbates ***any*** joint pathologies and their compensations!

Eventually, soles become very thick, the frogs widen and become weight bearing, and the (less often) loss of a shoe is no longer a lameness crisis. In correct feet, the natural breakover begins far behind the white line at the toe and on the inner third of the hoof wall from the front pillars through the quarters, especially with the hoof packed. The hoofs or shoes "working surface" should reflect this.

Natural feet do not bear weight on the toe wall when the horse rests. In the natural foot, toes are rolled, quarters are broken or flared, and the foot touches the ground surface through hoof pack, four inner wall corners, and often the toe callous and frog. The proportion of weight bearing on these structures is usually dependent on the size and weight of the horse, as well as his environment. Natural feet have more frog and sole contact through hoof pack and more dynamic change through movement. Heavier horses have more of their frog bearing weight and the hoof's breakover is further back in relation to the frog due to the increase in weight bearing requirement. When one or more of the following conditions exists, the breakover will be farther back:

- Increased weight bearing due to balance, lameness, or condition
- Flexor tendon contraction
- Calf kneed conformation
- Proportionately long cannon bones.

A way to explain, demonstrate, or prescribe what is needed to normalize the weight bearing surface of the foot beneath the bony column and neurologic receptors is to:

Step 1: Find the "center" of the foot (the fulcrum, "bridge", end of true bar, widest of sole), which corresponds to the center of rotation of the coffin joint. In a heavy weight bearing foot there maybe evidence of a thickening of the sole, bars, and frog at the "center" or end of the white line of the bar.

Step 2: Place the weight bearing surface of a trim or shoe so that there is the same distance from the "center" of the foot to the end of the posterior support base (which should extend to the widest of the frog) as there is from the "center" to the breakover. This often will place the breakover well behind the white line and the shoe heel very full, behind a low, under-run heel. If the heel is high and under-run, it can only be lowered to the widest of the frog without straining the tendons ***if*** the breakover is brought ***all the way back*** to the drop of the coffin bone tip.

SAME RATIO OF TOE LENGTH TO POSTERIOR SUPPORT FOR FEET OF A PAIR

The feet of a pair should have the same ***ratio*** of effective toe length to the posterior support. Nature will rapidly match the way feet function mechanically, even if the cosmetic appearance of the feet does not match. This is the way nature evens out club, upright, or lame feet over time.

The "posterior support base" is the distance from "Duckett's Dot" to the weight bearing back of the foot (the heel or the frog.) (See Figure 2 - *Leverage & the Natural Foot*) This is the only part of the foot designed for stabilized heavy weight bearing and contains some of the neuroreceptors which tell the animal how to place his legs underneath himself.

The distance from the breakover to the "center" of the foot is the effective toe length. The toe wall is designed for traction when moving, providing the foot's mechanical advantage and its leverage influences on the neuroreceptors in the heels, quarters, coronary band, and tendon stretch receptors.

The concept is simple – if the ***ratio*** of toe length to posterior support is made to be the same (through trimming and shoe placement) between feet of a pair, then the horse's neurologic

(mechanoreceptor) input from the feet will be mechanically symmetrical (see Figure 3 - *Biomechanical Symmetry Does Not Equal Cosmetic Symmetry*.) If mechanical and neurologic input are symmetrical, then foot placement will be symmetrical, and the horse's movement will also become symmetrical. The foot will then grow in response to the symmetrical forces and will eventually develop symmetrically (Wolff's Law, the tissues respond to the forces put on them). In short, if it works the same, it will feel the same. If it feels the same, it will be used the same. If it's used the same, it will grow the same.

Creating the same ratio of toe length to posterior support for feet of a pair will change and balance the horse's neutral posture and feeding stance more rapidly than any other approach. Given that the horse spends the majority of its day standing around and eating - if we balance these functions, we balance everything!

In the process of lameness recovery, we must help, not hinder nature's process. Nature breaks the clubfoot ***back***, lengthens posterior support on feet with long toes and low heels, and in general tries to return the feet of a pair to the same ***ratio*** of toe length to posterior support so that they will function similarly as quickly as possible, even though the feet may not be the same ***size***. Cosmetic symmetry of the hoof capsule and the actual size of the feet may lag behind in becoming symmetrical due to pathology, both in the feet and elsewhere, but functional biomechanics become symmetrical quickly in the wild; the lions make sure of that!

HIND FEET

Hind hooves are usually in better condition than most front hooves because current shoeing practices tend to create weight bearing surfaces closer to those nature intended – with breakovers set back and long bases of posterior support. The major adaptations in feeding stance and resting that we deal with in hind feet are long medial toe quarters and the subsequent problems with foot placement and delayed breakover. These problems are dependent on front breakover delay and will resolve after initial rebound of growth when the front feet function more appropriately, posture changes, and the hind legs are no longer overloaded.

Resolving the problems of unnatural front feet will minimize most hind leg lameness. However, we still must address the tendency toward problems with the excessive length of the medial side and toe quarter. The medial part of the foot elongates when the horse rests standing in "goat-on-a-rock" posture or with a foot unloaded. The lateral heel gets squashed, the medial side is unloaded, and the toe grows faster. This process encourages all lameness of the hind feet and legs.

Long medial toes and/or quarters exacerbate squashed heels, lateral flares, and separations. Collateral ligament injuries from twisting on the long medial toe pivot, compression of the medial hock joints (spavin) from inappropriate placement, lateral and posterior fixation of the stifle, medial condylar OCD, upward fixation of the patella, lateral hip dysplasia, "whorlbone" disease (trochanteric bursitis), "hock twisting", sacroiliac jamming and strain, and much back soreness are frequently secondary effects from both hind and front shoeing inaccuracies, breakover delay, and the resultant postural defects and excessive weight bearing.

To perform a simple modification of hind feet to help normalize function:

Step 1: **Bring the breakover back as described above.**

Step 2: **Lower medially to level - especially the toe quarter pillar (or beyond level, to reset neurologic program, as nature would in breaking off this large flare high on the wall).**

Step 3: **Ease medial breakover by rolling the toe, the pillar, or the medial toe corner of the shoe.**

Step 4: **Extend posterior support to the widest of the frog or to the hairline of the heel bulb if necessary for support, especially laterally.**

This hind foot balance change can dramatically alter posture and the use of muscle groups. Subtle changes in posture or leg placement can vastly improve performance and leg placement is neurologically influenced by breakover and balance of the feet.

A POSTURAL MUSCLE BALANCE CHANGE FOR YOU TO TRY…
Stand on the outsides of your feet and heels, with your feet parallel and pointing straight forward, then squat down a bit. Notice your balance and which muscles you tense as you straighten your legs and stand up. Next, try this again, but with your toes turned outward and your weight centered on your feet. Notice the change in your balance and the muscle groups that you now use when you stand up. This difference in balance and engaging this latter muscle group can make you a superstar!

ALL FEET

Compared to domestically kept horses, wild horses are able to maintain a better-balanced foot because their natural toe wears more. This increased wear is attributed to greatly increased activity. On the average, wild horses move twenty to forty miles per day over very rough terrain! If they survive to maturity, they often live well into their twenties, suffering very few of the common lamenesses of domestic horses in spite of their "high mileage". They tend to have very little muscle definition due to unbalanced development even though they are more fit than most race horses. Their backs do not become swayed, their feet and frogs are generally very symmetrical (unlike the majority of shod horses). Their demise is usually associated with the failure of their teeth, ***not*** their legs and feet! (See Figure 4 - *Goat-On-Rock Posture Variation with Uneven Ratios vs Normal Feeding Stance.*)

The hoof wall is dynamic and responds very quickly to weight bearing changes by bending, shifting, torquing, shearing, and breaking. Any consistent change in weight bearing or leverage will result in a distortion of the hoof capsule and coronary band prior to breakage. This distortion acts to minimize the excessive forces translated up the leg until the foot is modified.

Anytime there is too much leverage on the wall, a dish or collapse will occur in the wall. Anytime there is too much pressure on the wall from below, the coronary band will displace upward to relieve it. If these forces are not relieved, inflammation will result or scar tissue will form from the chronic pressure and will eventually be exteriorized as a coronary band abscess.

The resulting horizontal defect in the wall is nature's "tear here on dotted line" for relieving the leverage and jamming pressure as the wall grows down. If we are observant, we can provide relief without the abscess if the scarring and inflammation are not too great.

Therefore, the "rules of thumb" for correction of excessive forces on the hoof wall are:

- Where there is a dish or collapse - reduce wall leverage (at the breakover, quarter flares, or collapsed heels; especially for quarter cracks and under-run heels, also provide alternative weight bearing on frogs or sole pack.)
- Where there is a rise in the coronary band - reduce the height or length of the foot (beneath the jam, even to the point of "floating" the wall if necessary).

It should be noted that a dish and a jam can occur in the same area.

The nuances of application of this program are too extensive to cover completely in this presentation. Especially if technical application is inaccurate, the rapid changes in the hoof caused by postural balancing can be painful. However, when done properly, horses show dramatic and continued improvement, and return to their maximum performance potential, and have longer functional lives.

Ultimately, the formula for returning feet to normal function is to trim the hoof in the order and sequence that nature would wear it, if the horse were turned out barefoot on hard ground. We can manage this quickly, and without pain, if we are attentive and careful, and if we observe what the foot and horse are telling us, rather than adhering to strict convention and traditional shoeing formulas.

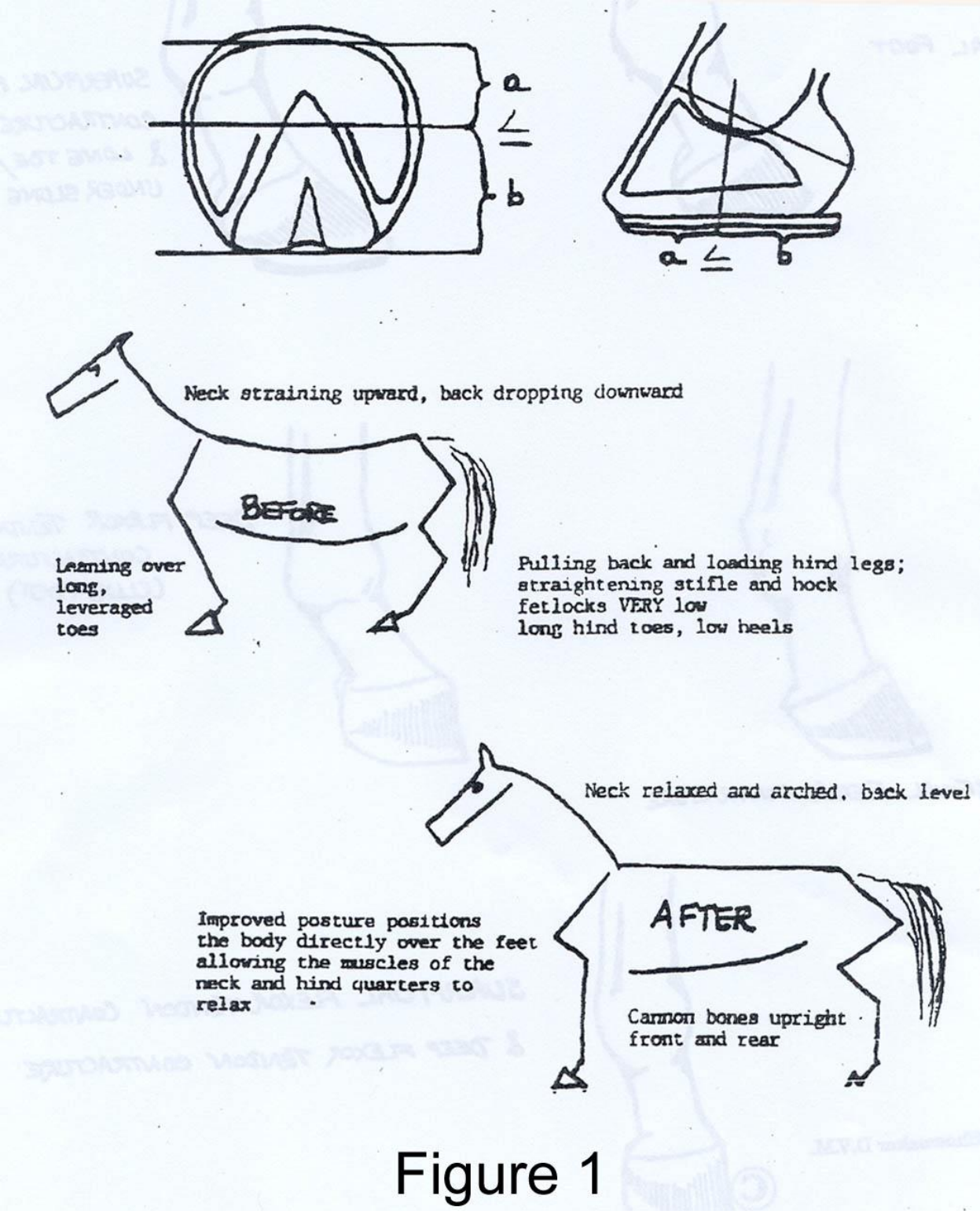

a
b
a ≤ b
Neck straining upward, back dropping downward
BEFORE
Leaning over long, leveraged toes
Pulling back and loading hind legs; straightening stifle and hock
fetlocks VERY low
long hind toes, low heels
Neck relaxed and arched, back level
AFTER
Improved posture positions the body directly over the feet allowing the muscles of the neck and hind quarters to relax
Cannon bones upright front and rear

Figure 1

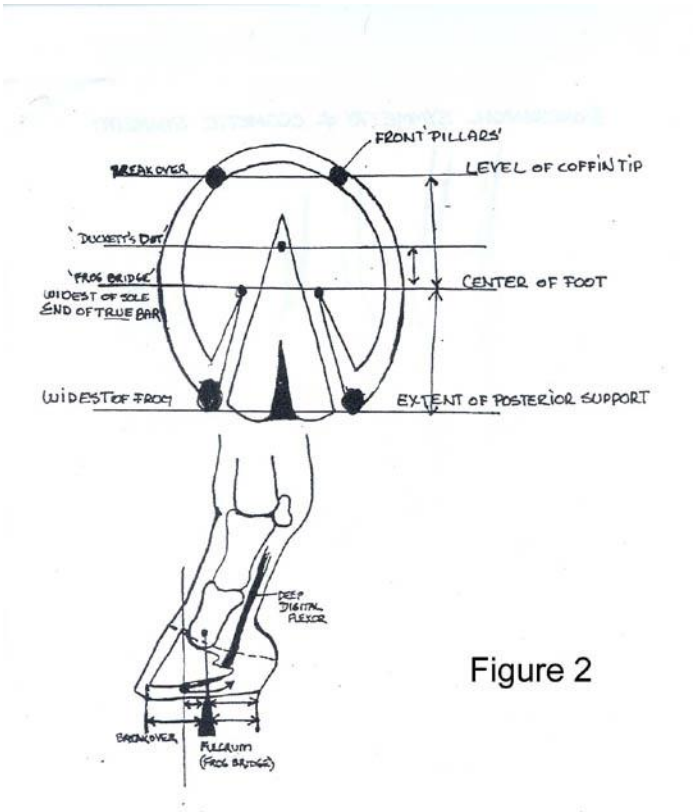


Figure 2

Leverage & The Natural Foot

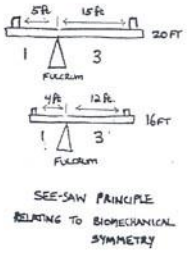
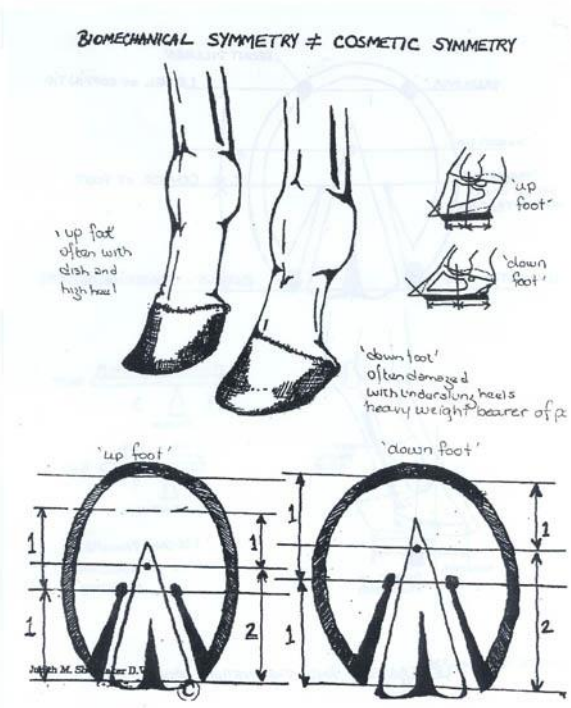


Figure 3



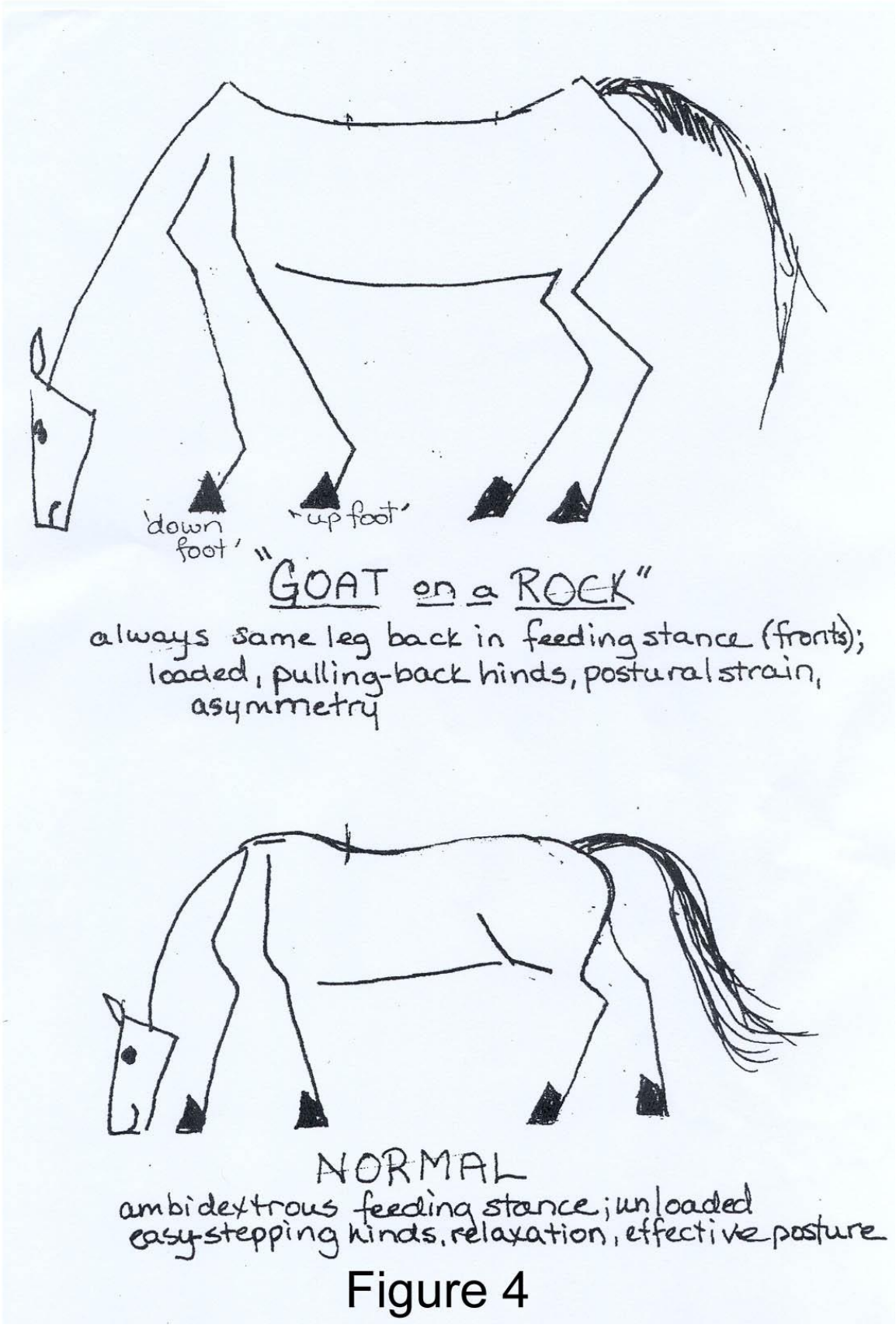

'down foot'
'up foot'
"GOAT on a ROCK"
always same leg back in feeding stance (fronts); loaded, pulling-back hinds, postural strain, asymmetry
NORMAL
ambidextrous feeding stance; unloaded easy-stepping hinds, relaxation, effective posture

Figure 4

SOURCES AND FURTHER READING

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(*The source of Mr. Bergeleen's publications and videos.*)

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