Lameness is a clinical sign. Detecting lameness and evaluating its amplitude is important to equine veterinary practice. Because it is important we should understand it well. Detecting and evaluating hind limb lameness, compared to forelimb lameness, seems to be especially difficult. To explain the mechanics of hind limb lameness detection and evaluation with nebulous, unmeasurable, and clearly subjective terms like “behind the bit”, “hind limb engagement”, or “hind limb impulsion” demeans the scientific reputation of our profession. We must, instead, use objective evidence to define clearly-understandable parameters that are sensitive and accurate for detection of lameness.

First and foremost is to understand that lameness in horses is most efficiently measured by tracking and evaluating vertical motion of the torso. Vertical motion of the torso follows and therefore mimics the reduced ground reaction forces that occur (and are understood on physical first principles) with lameness. Limb movement, especially during the swing phase of the stride, and pelvic rotations, are highly dependent on “other” factors besides lameness, most notably physical anatomy and conformation. There is a potential for many “false negatives” and “false positives” when using limb movement and pelvic rotation to detect and evaluate lameness in horses.

The concept of using vertical motion of the torso as the primary indicator of lameness in quadrupeds is relatively straightforward to understand. It is logical. To reduce force on a painful limb during weight bearing the torso will fall less, more specifically it will fall with less downward acceleration, since force = mass x acceleration. The torso will also rise less, with less upward acceleration during the second half of the stance phase of the stride. If the horse were an inanimate bouncing ball (and I realize that it is not) the sound horse would simply bounce up and down more than the lame horse. In fact, simply explained, this is indeed what happens. On closer inspection, however, by evaluating both the upward and downward movement the entire pelvis, more information about the lameness, besides which hind limb is involved and the amplitude of lameness, can be acquired. The trajectory of vertical pelvic vertical movement also contains information relating to the timing of lameness within the stride cycle.

There are many descriptions of what motion parameters are good for picking up hind limb lameness in horses in textbooks, but I personally have found them either to be too difficult to understand and remember or misleading. As with the forelimb there are many movement parameters that are purported to indicate hind limb lameness, including joint flexions, how the limb swings forward, and especially pelvic rotational movement (which encompasses the phenomenon of “hip hike” and “hip dip”).

However, similarly to looking at vertical head movement to detect forelimb lameness, all the information that is needed to detect hind limb lameness can be found in the pattern of vertical movement of the entire pelvis. Other methods including limb movement and, more importantly, pelvic rotation are less sensitive and, in certain circumstances, may give false positive (looks lame but is not) or false negative (does not look lame but is) evaluations.

The two methods that are most used by practicing equine veterinarians are the pelvic rotation method, which is sometimes explained as “hip hike” and sometimes as “hip dip”, depending on what you are looking at, and the vertical pelvic movement method. Experimental evidence and clinical experience suggests that vertical movement of the entire pelvis is less prone to error than the pelvic rotation method. Comparing these two methods of evaluating pelvic movement to detect hind limb lameness in horses is instructive.

Let us first outline each method. First the vertical pelvic movement method observes the vertical movement of the pelvis as if it were one big ball. Disregarding pelvic rotation the observer looks at the vertical movement of the pelvis over time. Instead of seeing the entire pelvis as a large ball, which is difficult, the observer could, alternatively, observe a spot on the dorsal midline of the pelvis. With this method the observer observes for both less downward movement coming down onto the lame limb and less upward movement coming off the lame limb. This can be easily explained as either less impact (less downward movement of the pelvis) on the lame limb or decreased propulsion from the lame limb. So the pelvis “ball” either reaches a higher minimum during weight bearing or a lower maximum during swinging of the limb forward. The higher minimum occurs during stance and the lower maximum occurs right after stance of the lame hind limb.

The second method, the pelvic rotation method (“hip hikes” and “hip dips”), is easier to see since the total excursion of movement is greater, but conceptually it is more difficult to explain. With this method the observer actually evaluates amplitude of vertical movement of the tuber coxae (not really the “hip”) on the left side and compares it to that of the right tuber coxae, with the lame side either moving up more (a “hip hike”) or down more (a “hip dip”) than the sound side. The first fact to note when observing vertical tuber coxae movement is that, even in the sound horse, the trajectory is asymmetric. You cannot simply look at the pattern of tuber coxae movement in isolation (as you would evaluate head movement for forelimb lameness or vertical pelvic movement for the first method of detecting hind limb lameness) and determine lameness, you must compare amplitude from side to side. The second fact to
note is the timing of pelvic rotations. The pelvis is even, i.e. not rotated, with approximately equal height of each tuber coxae relative to the ground, right before impact of one hind limb (which is the same time as right after pushoff of the other hind limb). Essentially the pelvis is not rotated when the horse is airborne with no hind limbs touching the ground. The begins to rotate during weight bearing with maximum pelvic rotation occurring at about midstance of each hind limb and the rotation is toward the weight bearing hind limb. Thus, viewed from behind the horse, the pelvis is rotated clockwise when the right hind limb is on the ground, and counterclockwise when the left hind limb is on the ground. Also, highest vertical positions of the tubera coxae occur during the airborne phase of the hind limb stride and lowest positions occur during the weight bearing phase of the hind limb stride. “Hip hike” and “hip dip”, despite what some have suggested, are not the same events, since they do not occur at the same time within the stride cycle. “Hip hike” occurs right before impact of the lame hind limb and “hip dip” occurs right after pushoff of the lame hind limb. Why is this?

The horse uses its ability to rotate the pelvis with hind limb lameness similarly as it uses it head in forelimb lameness when landing on painful forelimb. Right before impact of the lame hind limb the horse will rotate its pelvis away from the painful limb that is about to impact the ground. Thus the tuber coxae is rising as the pelvis is falling. This is “hip hike”. If the pain of lameness is greater during propulsion (pushoff) the horse will simply not push off the affected hind limb with as much force as normal. The pelvis will subsequently rise (and move forward) less. It will be closer to the ground after pushoff of the lame limb. In order for the horse to bring the affected limb forward during the subsequent swing phase of the stride without dragging it on the ground (remember the pelvis is closer to the ground than it should be), and in fact sometimes it still does, the horse will have to flex the entire limb more than usual. This limb flexing rotates the pelvis towards the lame side and the tuber coxae moves down more than normal. This is “hip dip”.

However, which method is better, the vertical pelvic method or the rotation method? Experimental evidence suggests that, although more difficult, the vertical pelvic movement method is better. It is better because it is more sensitive, plagued less with false positives, and more robust. The vertical pelvic movement method mimics, actually is the direct result of, hind limb ground reaction forces. By contrast, the pelvic rotation method is more dependent upon anatomy and conformation, both of which may be asymmetric despite the horse landing and pushing off left and right hind limbs equally. Lastly, the vertical pelvic movement method is robust because it can be observed from any vantage point. The pelvic rotation method is difficult to use when viewing perpendicular to the horse’s direction of motion. You really must be behind the horse to adequately assess left to right asymmetry, and unless you are going to run behind the horse (or view the horse on a treadmill, which has its own difficulties), spatial resolution decreases quickly as the horse moves away.

Core information in support of these proceedings can be found in the following manuscripts and text chapters

References