The Biomechanics of Jumping
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Jumping can be a demanding sport for the horse, however, as with most everything it depends on how it is done. The big difference between jumping and other types of equine activities is the force of gravity that the horse must overcome during take off, and then reduce upon landing. The force on the horse’s foot upon landing from a 2-foot jump is about 3156 pounds, and landing from a four-foot fence places about 4509 pounds on one foot.

There are two types of forms the horse can use for jumping. The first form is simply a longer and slightly higher canter (or gallop) stride. The second form requires a change in the horse’s body mechanics to create an actual jump stride. The height of the fence generally determines which of these positions the horse uses. Typically, over higher fences the horse will actually use a jumping stride, while over smaller fences the horse only uses the longer canter stride to jump. However, some horses will use a jumping stride over a small fence (desirable) and use a canter stride over a large fence (not desirable).

What specifically is the difference between these two forms the horse can use to jump a fence? During the canter-stride jump, the horse does not have a moment of suspension, or hesitation, before the take off to gather energy. This moment of hesitation will be further discussed in the “TAKE OFF” section below. The canter-stride jump feels like the horse simply lunges at the jump in hopes of making it over, due to forward momentum, and usually some luck.

The gait the horse uses to get to the point of take off for the jump can be the walk, trot, canter or gallop, and as we all know, the horse can even jump from a stand still. Some horses prefer one gait to the others for take off. In addition, the horse can be encouraged to improve their form over the fence by selecting the correct take off gait.

We have all felt how some high jumps may feel effortless while a low fence can jump us right out of our tack. A look at the mechanics of the horse over a jump will help to understand how to help the horse to be better balanced, therefore reducing the trauma to the horse’s body. This review is based on excerpts from several research papers looking at high-speed video to determine exactly what occurs when the horse jumps. So, here is what generally will happen during APPROACH, TAKE OFF and LANDING when a horse is correctly jumping.

APPROACH
The horse must get to the base of the fence at an even and steady gait so that she can concentrate on the best spot to take off for the jump. In general, the faster the approach the more skill and strength the horse needs to jump correctly. For the horse to obtain the maximum amount of push of the hindquarters, the forward momentum of the horse must be stopped for a brief moment as the horse gathers energy to jump.
FIGURE 1
Approach and Take Off – Right Lead Canter
TAKE OFF

1. As the horse finishes the last complete stride before the jump, the horse will begin to shift the weight backward by beginning to raise the head, shorten the neck, and lift the shoulders.

2. The horse’s neck continues to shorten to assist in moving the weight backward. This shortening of the neck also helps to abort the normal forward movement of the canter. In a sense the shortening of the neck sets up a wall that the rest of the horse’s body will move up to.

The shoulders of the horse continue to lift and rotate up and back.

3. The first hind leg to land at the base of the fence is the first beat of the canter, which is the non-leading hind. As the weight is shifted back, the horse will interrupt the normal forward swing of the leading hind leg so it takes a shorter stride and therefore ends up even with the first hind leg to land (non-heading hind). If this does not happen, then the horse will take off with one hind leg (the leading hind) in front of the other hind leg.

For example, if the horse approaches on the right lead as in the illustration (FIGURE 1) then the left hind (#1) is the first beat of the canter, and will land first (FIGURE 2). The second beat of the canter is the right hind (#2) and left front (#2) together. In a typical canter stride, the right hind will then land ahead of the left hind, because the left hind is already on the ground. To obtain a well-balanced take off the horse’s hind legs should be even, therefore the right hind will abort its normal forward swing to end up even with the left hind making it easier for the horse to rock the weight backward. This moment of interruption of the forward movement of the hind leg is an important one. If this moment doesn’t happen, the horse cannot be ideally balanced to flex their hind limbs for take off, because the hind legs are not even.

Once the weight is shifted backward, the horse can then lift the front legs off the ground. The front legs curl in toward the body due to the backward and upward rotation of the shoulders. This position makes the horse’s body more streamlined so that less force is required to move the body over the fence.

4. As the weight moves backward, the hind legs compress or coil to create the energy needed to propel the horse over the fence. All joints of the hind legs should be flexed equally so that no one joint is pressured more than the others. This flexion includes the rotation of the pelvis due to the flexion of the sacral and iliac junction in the loins.

With the maximum amount of flexion in the hind joints, the horse can then create the maximum push against the ground to propel the horse up and forward over the jump.

The longer the stance phase during this period of hesitation, the more force the horse can create, up to a certain point. Of course, too much stance phase can turn into a stop at the base of the fence! However, in general, as the speed of the approach gets
faster, the stance phase is reduced. If the horse comes at the fence too quickly, then there may not be enough time for the horse to create a good solid stance phase. Without a good base of support, it will be difficult for the horse to have the time to coil and push hard against the ground to get a good take off. It takes an agile and strong horse to obtain the coil and push necessary if the stance phase is short.

This hesitation is one of the main factors that determines if the horse will choose a long canter stride or an actual jumping motion over the fence. The higher the horse jumps the longer this moment of hesitation will be, because more coil will be needed. I remember learning this through the technique of walking a horse up to a high fence. Now, of course not all horses can be asked to do this, but with a compliant horse, this can really illustrate to the rider that faster is not necessary better!

This moment of “hesitation” can be the hardest on the horse and rider for they both feel that the jump could stall out at this point. The natural tendency for both horse and rider is to lunge forward too quickly at this moment and never reach the full compression of the joints. It takes time and patience, and slow increases in jumping height to gain this skill for some horses and riders.

The horse can have the most effective take off when the hip joint is placed vertically above the hoof.

5. Once the maximum flexion of the hind legs is obtained, then the horse extends and releases the coiled energy. One of the important concepts that a human high jumper figures out quickly is that if they do not have a good “coil” they will not have a good jump.

The hind legs are in full extension right before they leave the ground. The force the horse must exert is greater than the weight of the horse’s body or the horse will not leave the ground.

The abdominal muscles of the horse will really start to come into play at this point as the horse begins to lift the top line to clear the fence.

During this phase, the back and shoulders extend, but the neck remains relatively short. The horse’s shoulders rotate up and forward helping to pull the hind legs off the ground.

**FLIGHT**
The hind legs reach maximum extension after they leave the ground and the front legs are curled tightest against the body.
As the hind legs leave the ground, the height the hind legs can obtain has now been ideally determined. The power to clear the fence with the hind legs is proportional to the strength of the coil, and the push of the hind legs against the ground.

However, as we know, the horse can be quite creative and if there is not enough power to get the hind legs over the fence, the horse will sometimes twist the pelvis to lift the hind legs higher. Or if the forelegs are too low, the horse will throw the shoulders sideways to clear the fence. Of course, this is very detrimental to the mechanics of the horse’s body and over time can cause lameness problems.

The neck begins to extend further forward to assist the body in the forward movement necessary to reach over the fence and obtain the scope necessary, especially important when jumping oxers.
As the forehand extends, the hind legs swing forward beneath the trunk, bending in the stifles and lifting in the hocks.

The knees lift and bend to curl the legs up under the forehand, the tighter the better so the chance of hitting the fence by the front legs is reduced. **To bend the knees and lift the forehand the scapula (shoulder) rotates upward and forward.** If the forelegs dangle, then the horse must exert much more force to clear the fence because the torso must be raised higher. Most horses will learn to lift their knees so that they do not have to lift their torso higher, which is much more difficult. Also flexion in the knees will pull the knees closer to the horse’s body making the horse more streamlined.

**LANDING**

1. To slow the forward momentum so that the force of impact is reduced, **the horse will swing the neck and head up as the forelegs reach toward the ground.**

2. The non-leading front leg (right front in FIGURE 2) lands first. **When the leading front leg lands, both legs push against the ground in an upward and backward direction.** This upward and backward motion is extremely clear when riding the landing of a drop fence. The quick reduction in forward momentum as the front legs touch the ground after a drop fence can send the rider over the horse’s head if the rider is slightly too far forward.

The hindquarters rotate underneath the trunk, and reach toward the ground as the forehand moves forward and out of the way of the hindquarters.

**SUMMARY**

The methods used to teach a young (or old) horse how to jump have many variations. The slow, steady repetition of the same movement will train the neuromuscular system to perform consistently at a high-ability level, even under stress. In the early stages, correct jumping form is extremely important, and how the trainer obtains that is multifaceted. One thought is to configure the training so that the correct form for the horse can be obtained with the horse jumping free. Once the horse is comfortable with free jumping and has learned how to balance only their body over the fence, then the weight of the rider can be added. This method is not always possible because many horses need the guidance of the rider to obtain the correct jumping form. However, if possible, free jumping may be a good bridge between the skills the horse must obtain to move balanced on the flat and then must have to be balanced over fences.