

"A gifted horse will lead a good rider to victory. A great rider will give to the horse the gift of soundness." Jean Luc Cornille Even the most benign medication has side effects. Aspirin for instance, may upset one's stomach. Curiously, while the advantages of lungeing are often promoted, the negative effects are rarely addressed. It is evidently considered safer to have a horse bucking with excessive energy at the end of the lunge line, than under saddle. The damages created by extended lungeing sessions, however, are severe and definitively need to be exposed.





• The first fallacy to correct is that a horse does not bend at the end of the lunge line. The horse might bend the neck under the restraint of side reins or other system, but does not bend the thoracic vertebrae. As a result, the horse leans inward on the circle.



As I started the study, lungeing proponents argued that "maybe other trainers' horses do not bend circling at the lunge line, but my horses do bend their thoracic spine." I took pictures and recorded videos of seventyeight horses, their horses, and other trainers' horses. The recordings covered all type of lungeing systems and all disciplines. Without exception, each horse was holding the thoracolumbar spine straight leaning inward the circle. The average body angle was 67°.

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Horse leaning inward

Exploring the thought that maybe the lungeing techniques were to blame, I researched equestrian literature and found that our ancestors were aware of the problem, describing it as *keeling over on the circle*.

Hind and Front Legs' Damages



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Due to the horse's body inclination, the hoof of the inside hind leg as well as inside foreleg impacts on the outside wall while the hoof of the outside hind and front legs alights on the inside wall. Such impact induces abnormal stresses on the fetlock, knees, and hocks joints.



Outside hind leg impacts on the inside wall

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Inside front leg impacts on the outside wall If we focus for instance on the outside hind hoof, impact occurs on the inside wall. Such impact produces abnormal stresses on the hock joint. *"Preferential support of the hoof on the inside wall during ground contact and push-off concentrates compressive forces on the internal face of the hock joint, where the articulation is particularly prone to degenerative phenomena (athrosis) leading to sparvin."*

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"There is no evidence that sparvin is other than an arthrosis of the joints between T3-Mt3 and/or T3-TC. If oesteophytes have not yet formed, the lesion is blind or occult, with degenerative, ulcerative changes in the articular cartilages. When osteophytes have formed as a result of the cartilage damage, it is termed a bone sparvin. In reality of course, these are one and same process viewed at different stages of development." (James R. Rooney, Biomechanics of lameness in horses, 1969)



Immediately after impact, the hoof turns flat on the ground inducing,

1. Compressive forces on the cartilage surfaces of the lower joints.

2. Torsion on the articular capsules.

3. Strains on the ligaments

By contrast, the hoof of the inside foreleg absorbs the impact forces on the outside wall. Immediately after impact, the foot turns flat on the ground creating compressive forces on the cartilage surfaces of the lower joints, torsion on the articular capsules, and strains on the ligaments. The outside front hoof impacts on the inside wall. Due to the centrifuge effect of the circle, briefly after ground contact, the fetlock undergoes an outward shift, stressing the suspensory ligaments. The same phenomenon occurs with the outside hind leg. On the picture, the right line illustrates the position of the outside hind leg's fetlock at impact. The red line indicates the position of the fetlock 0.75 of a second later.

The lateral sliding of the fetlock is likely to delay the upward translation of the fetlock creating an out-of-phase rotation of the hock joints. In motion, fetlock, hock, and even stifle joints undergo inward rotations synchronized with the flexion and extension of the joints. Basically, inward rotations of the hock's two lower joints are synchronized with the down and up translations of the fetlock. By contrast, inward rotations of the hock's two upper joints are synchronized with the flexion and extension of the stifle. When the hind legs' kinematics is proper, inward rotations occur in harmony. When the upward translation of the fetlock is delayed, inward rotations of the hock's two lower joints are out of phase. Occurring stride after stride, such asynchronization is likely to create problems between Mt3 and T3 or T3 and TC.



The Synarthrotic or Close-Packed Position



The stability of the hock at impact is also a problem that can be considered. A joint like the fetlock does have a position referred to as *close-packed* or *synarthrotic* where the two articular surfaces of the joint have maximum surface contact, maximum congruity, and therefore, are able to receive the greatest compressive force. The synarthrotic position is usually at one extreme of movement. By contrast, the hock's synarthrotic position is at the middle of the range of motion. Practically, the angle of the hock at impact, (dorsal angle 147-150^o,) is about the same than the angle of the hock during normal standing position.

During propulsion, the hock leaves the synarthrotic or close-packed position and is submitted to great force. The stability of the hock joint is then fully assumed by a complex system of muscles, tendons, and ligaments.





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"During propulsion, the tibiotarsal joint leaves the closepacked position and, because great force is being applied to the joint in a non close-packed position, the rationale for the gastrocnemius, biceps peroneus, tibialis cranialis stabilizing system is apparent." (James Rooney, 1969)



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The hock is perfectly designed to support very strong stresses as long as the joint functions in proper alignment and synchronization. The lunge situation creates two potential problems. The first is that the obliquity of the horse's body places the hock joint in a vulnerable angle.



The second issue is not likely to damage the horse if the lunge work is executed at a slow cadence. The problem becomes acute when the horse is rushed forward and so, turns quickly on a circle. The horse stiffens the back in order to increase the speed. When, circling on the lunge line, and a horse is activated faster than his natural cadence, the horse necessarily functions with the back contracted. Stiffening of the thoracolumbar spine alters dorsoventral tilts of the pelvis, hampering the kinematics of the hind legs. The outside hind leg is then likely to impact too early, creating a situation referred to as *functional straight hock*. By contrast, the inside hind leg may alight too far forward creating the situation of a *functional sickle hock*.



Functional straight or sickle hocks create the same damages that morphological straight or sickle hocks do. Straight hocks are more prone to Mt3-T3 lesions. On the other hand, sickle hocks are subject to TC-T3 lesions.



Speed and Vertebral Column Rigidity

Speed is created with a stiffening of the horse's thoracolumbar spine. Vertebral column rigidity is not a defect that can be resolved with stretching exercises. Rigidity is way that the horse's vertebral column converts the thrust which is generated by the hind legs into speed. "At speed higher than the walk, the amplitudes of the axial movements are reduced and difficult to discern with the naked eye. Presumably the muscular resistance increases, making the vertebral column as nearly rigid as possible in order to resist wasteful sidewise, lateral motion." (Rooney, **1969**) Rushing the horse forward, and then attempting to ease the vertebral column rigidity through stretching postures is a physiological incompatibility.



The *system* persists in the assumption that the horse's vertebral column is a stretchable and swinging unit. The thought perpetuates the erroneous idea that better gaits and greater performances can be achieved by increasing the horse's vertebral column's range of motion.

The reality is exactly the opposite. The primary function of the back muscles is to preserve the stability of the vertebral linkage. Therefore, do not allow movements of the thoracolumbar spine which exceed the spine's possible range of motion. Instead of stretching and relaxation of the back muscles, gaits and performances rely on the subtle orchestration of numerous and minuscule contraction and compensatory contraction of the epaxial spinal muscles.



The muscular coordination is extremely complex. There are for instance 183 synovial articulations in the equine vertebral column and the range of movement in the dorso-ventral direction is only 2.25 inches. Therefore, any situation creating spinal rigidity, such as speed, hampers the capacity of the horse's central nervous system, the brain, to properly coordinate the work of the epaxial spinal musculature.



The question may be how to distinguish speed from forward movement. The first response came at the 18th century: "*Do not confuse speed and impulsion.*" The warning has since been reiterated from classic author to great masters. More recently, scientific studies clarified the thought. Studying African animals that migrate over long distances, a biologist named Pennycuick observed that within each gait, animals always maintain the same range of speed.



Studying the phenomenon from the perspective of oxygen intake, the biologist found that there was a cadence where, for a given oxygen consumption, the animals were traveling a longer distance. Pennycuick concluded that it was a cadence where the locomotor system was functioning at maximum efficiency. This cadence can be referred to as the *natural cadence*.



The study was extended to horses, finding similar results. The concept was then approached from the perspective of muscle fatigue. A horse walking at a fast walk, for instance, will use more muscular work than working at a slow trot. *The horse's natural cadence* is the cadence where the horse's locomotor mechanism is designed to function optimally. The *natural cadence* varies from one horse to the other, but can be regarded for all horses as

the reference in terms of speed. Circling at the end of the lunge line or while under saddle, a horse which is rushed forward at a speed greater than his natural cadence will stiffen the thoracolumbar column.



Until technology provided a means to measure the forces created by the hind and front legs, the incapacity of the human eye to register fast movements lead to the belief that the hind legs were producing the greatest percentage of upward propulsive force. In reality the forelegs are producing more vertical impulse than the hind legs. "In horses, and most other mammalian quadrupeds, 57% of the vertical impulse is applied through the thoracic limbs, and only 43% through the hind limbs." (H. W. Merkens, H. C. Schamhardt, G. J. van Osch, A. J. van den Bogert, 1993). A horse trotting at his natural cadence demonstrates the phenomenon. The horse jogs effortlessly, bouncing from one diagonal to the other. On the lunge line, the visual impression is easiness, quietness, slow rhythm, and suspension. Under saddle, the feeling is comfort, lightness, suspension and cadence.



Lungeing Systems



Many systems, which are applied on the lunge line, chambon, gogue, elastics, draw reins, etc., are supposedly designed to increase the horse's vertebral column's range of motion through a lowering of the neck. Based on the belief that the hind legs are producing the greatest percentage of upward propulsive force, these lungeing systems dismiss the fact that the lowering of the neck increases the weight on the forelegs, even though measurements made possible by modern technology raise serious concerns about the value of training systems that increase the load on the front limbs. The forelegs, instead of the hind legs, produce the greatest percentage of vertical impulse. Increasing the load on the forelegs handicaps the horse's ability to move and perform efficiently. Loading the forelegs also predisposes the horse to injuries.



Without going into too much detail, a look at the biomechanics of the forelegs exposes the occurrence of elastic recoil. "The muscular work of galloping in horses is halved by storing and returning elastic strain energy in spring-like muscle-tendon units." (Alan M. Wilson, M. Polly McGulgan, Anne Su & Anton J. van den Bogert - 2001)



Elastic structures, like tendons and ligaments, store energy when elongated. This energy is released when they return to their normal length. In the Wilson, McGulgan, Su, and Van den Boggert study, they compare the work of the forelegs to a child's pogo stick. The spring of a child's pogo stick is designed to store and return energy under the load of a child. If an adult plays with the child pogo stick, the spring will compress under the load but will not have the integrity to bounce back. Similarly, if over-loaded, the spring-like muscle-tendon units of the forelegs will not have the capacity to produce the normal amount of upward propulsive force. Consequently, the quality of the gaits will be altered and the horse's soundness will be compromised. Injuries are often the outcome of repetitious abnormal stress. Individually, each stress does not alter the integrity of the biological structure, but the repetition of abnormal stresses causes breakdown.



The second misconception emphasized by these lungeing systems is that gait and performance can be enhanced by increasing the amplitude of the horse's vertebral column movements. The muscles surrounding the vertebral linkage are designed to precisely protect the vertebral column structure from movements exceeding its possible range of motion. Considering that the maximum range of movement of the horse's thoracolumbar spine in the dorsoventral direction is only 2.25 inches, the concept of increasing the swinging motion of the horse's vertebral column is clearly inaccurate. Instead, better gaits and performances result from greater orchestration of numerous and minuscule muscle contractions and compensatory contractions.







In theory, the side reins enhance the horse's vertebral column's mechanism through adequate flexion of the neck. Considering the shape of the cervical vertebrae, the side reins have a 50% chance to succeed and a 50% chance to fail.



If the horse does not push on the bit, and increases the tone of the extrinsic muscles that sustain the trunk between the forelegs, while coordinating efficiently the rotary systems of the vertebrae, then the thrust generated by the hind legs and traveling forward through the spine, might enhance the work of the horse's vertebral column. This chain reaction, which can be labeled a *cervico-thoracic flexion*, may enhance the biomechanics of the horse's vertebral column.



In contrast, if the horse pushes on the bit, over-flexes the upper neck, and travels faster than his natural cadence; the side reins will likely stimulate a lowering of the trunk between the forelegs



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Lateral Bending

Lateral Bending



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Lungeing systems that are designed to bend the horse's neck laterally, also have numerous side effects. Lateral bending of the horse's vertebral column is always associated with a movement of transversal rotation. Conversely, transversal rotation is always coupled with lateral bending. "In the cervical and thoracic vertebral column, rotation is always coupled with lateroflexion and vice versa." (Jean Marie Denoix, 1999). For the same lateral bending, one rotation is *proper*, allowing the horse to perform efficiently. Another rotation is inverted, handicapping the horse's gaits and performances. **Right lateral bending**





Practically every lunge systems that bends the horse's neck laterally places the horse at risk of inverted rotation. The damages are inevitable, but the location of the damages depends upon the individual horse. Any vertebral column dysfunction will induce abnormal wear and tear on one limb or the other.



For instance, lateral bending of the neck is often created by a shortening of one side rein or by passing the lunge-line through a ring of the surcingle. Both approaches induce inverted rotation, which shifts the weight onto the outside shoulder. Oftentimes, the spinal torsion also induces a shift of the croup toward the inside of the circle. At the level of the outside foreleg, the increased weight will aggravate the stresses on the fetlock joint. The load will also hamper proper kinematics of the front limb. Instead of propelling the horse upward, as the front leg is designed to do, an excessive load on the outside foreleg will force the limb to control balance by increasing its braking activity. The result will be greater rigidity of the thoracolumbar spine and further deviation of the pelvis.



At the level of the hind legs, inward deviation of the pelvis will alter the kinematics of both hind limbs, by aggravating the stresses inherent to the lunge situation, and therefore multiplying the risks of fetlock, hock, and stifle injuries. *"The biomechanics of the vertebral column, although very complex, are of vital importance because they form the basis of all body's movements," (Leo B. Jeffcott, Natural rigidity of the horse's backbone – 1980)*



I do not advise anyone to lunge their horse unless it is necessary for their safety. I personally use the lunge if I must, but as rarely as possible. There are several techniques that can be used to minimize the side effects. One is to jog the horse at his natural cadence. The second is to incorporate as many straight lines as possible. For this reason, I never use the round pen. General Decarpentry, who authored *Academic Equitation*, proposed a lunge technique that incorporates circles with straight lines.



Chazot & Jean Luc



Here is an example of lunge work that reduces the stresses on limbs joints and vertebral structure. The horse is jogged at his natural cadence and works very often in straight lines.



The bottom line is that the biomechanics of the horse's vertebral column cannot be properly orchestrated by acting on the vertebral column's extremities, with the hind legs at one end and the flexion of the neck at the other. Each vertebra converts the thrust generated by the hind legs into locomotory forces (horizontal forces,) and forces which resist accelerations of gravity (vertical forces.) This intricate coordination occurs within the limits of a very restricted range of motion. The subtlety that is necessary to act efficiently on this complex mechanism lies in the sophisticated control of the rider's vertebral column. There is no substitute for correct riding.

Jean Luc Cornille

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- (Jean Marie Denoix, Biomechanique et travail physique du cheval de sport, 1986)

- (James R. Rooney, Biomechanics of lameness in horses, 1969)

- (H. W. Merkens, H. C. Schamhardt, G. J. van Osch, A. J. van den Bogert, 1993)

- (Alan M. Wilson, M. Polly McGulgan, Anne Su & Anton J. van den Bogert, Horses damper their spring in their strides, 2001)

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