

Stringhalt, Shivers, and Other Hard-to-Classify Movement Disorders

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CONTROL OF MOVEMENT BY THE EXTRAPYRAMIDAL SYSTEM

Normal movement is produced and coordinated by a group of interacting motor centers distributed throughout the brain at sites including the motor cortex, interior cerebrum, and brainstem. Collectively, these motor centers and their connections are known as the **extrapyramidal system (EPS)**. Even the most simple movements are guided by proprioceptive or other sensory input from the body and limbs, vestibular system, and cerebellum, and regulated and fine-tuned through inhibitory and stimulatory feedback loops within the extrapyramidal system and its connections. When the properly modulated motor signals are generated by the EPS they are conveyed by upper motor neurons that originate in the brainstem motor nuclei (red, vestibular, reticular) and project through the white matter of the brainstem and spinal cord to synapse on lower motor neurons (alpha, gamma motor neurons) in the grey matter of segments which, for example, supply the plexuses and peripheral nerves of the thoracic and pelvic limbs.

MOVEMENT DISORDERS

Movement disorders (dyskinesias) result when there is dysfunction of the precisely orchestrated neurological control of motor activity. Generally, movement disorders manifest as sudden involuntary contraction(s) of a group or groups of skeletal muscles. They may occur during rest or activity in animals that are conscious and have a normal sensorium. Movement disorders may be caused by discrete anatomical lesions within the EPS or its connections or dysfunction at a subcellular level of the circuitry of the EPS (e.g., genetic or toxic ion channelopathy), but in many cases the pathogenesis is unknown and recent evidence suggests that some syndromes are actually peripherally induced. Neurologic dysfunction/injury underlying a movement disorder may be inherited/congenital or acquired due to toxins/medications or degenerative conditions.

There are 31 categories (with many more subcategories) of movement disorder described in human neurology. A few relevant to horses are described here.

Tremor: Rhythmic involuntary oscillations or twitchings of the muscles of one or more body parts, usually with a rate of 3 to 10 Hz (events/sec).

Tic: Sudden, repetitive, nonrhythmic movement or vocalization involving discrete muscle groups

Dystonia: Sustained muscle contractions, often repetitive and often resulting in abnormal postures

Stereotypy: Repetitive or ritualistic movement or posture

Tetany: Intermittent sustained contraction of extensor muscles

Myoclonus: Myoclonus refers to a quick, involuntary muscle jerk or series of jerks, frequently involving simultaneous contraction of opposing muscles.

STRINGHALT

Stringhalt is a condition of horses characterized by sudden exaggerated flexion of one or both pelvic limbs during the swing phase of locomotion. Two distinct syndromes are recognized: **classical stringhalt**, a persistent condition of individual horses involving only one limb, and bilateral or Australian stringhalt which involves both pelvic limbs and occurs in outbreaks in horses at pasture. Both forms occur worldwide but **bilateral stringhalt** is most common in Australasia, South America, and the western US.

Clinical Signs

The defining clinical sign of stringhalt is abrupt hyperflexion of the hock and stifle during attempted movement. In classical stringhalt only one limb is affected; by contrast, Australian stringhalt is almost always bilateral although signs may be asymmetric. Stringhalt is most evident during backing, sharp turning, when going down a slope, after a sudden stop, and during the transition from standing still to

walking forward. Signs may be exacerbated by excitement, cold weather, or hard exercise. The clinical presentation of stringhalt varies greatly, even among horses with bilateral stringhalt grazing the same pasture. In mild cases flexion is only slightly exaggerated and pelvic limb action may be completely normal at gaits above the walk. Such horses are able to perform without impairment. At the other end of the spectrum, the upper joints of the limb flex so violently that the dorsum of the fetlock slaps against the horse's abdomen with each stride. When the condition is bilateral, the result is a bouncing bunny-hopping gait in which "progression can only be accomplished with a series of bounds and plunges extremely painful to witness". In the most severe cases, movement is impossible. An atypical bilateral stringhalt syndrome is described wherein the forelimbs also are involved and there are signs of generalized weakness. 9/70 horses with stringhalt in France had signs of obtundation or increased aggressiveness. A variable proportion of horses with bilateral stringhalt have abnormal laryngeal movement, stridor, or abnormal vocalization. Onset of stringhalt is usually sudden. Signs may fluctuate but tend to worsen over several weeks in horses with bilateral stringhalt, before plateauing, often for several months, then beginning to improve. Within 2 weeks after onset of severe bilateral stringhalt, atrophy of the muscles of the gaskin and, less obviously, the thigh and other parts of the body, becomes apparent. Horses with severe or atypical bilateral stringhalt may develop profound generalized neurogenic muscle atrophy that results in marked weight loss despite normal appetite and food consumption.

Clinical Pathology

No abnormal clinical pathologic findings are associated with stringhalt. Electromyography of affected muscles reveals increased insertional activity and abnormal spontaneous activity, such as fibrillation potentials and positive sharp waves, consistent with denervation. Nerve conduction velocity is slowed in the peroneal nerves of affected limbs, indicating demyelination, and improves as animals recover clinically.

Pathophysiology

The cause of classical stringhalt is unknown. Foot conditions and articular lesions of the hock or stifle are possible risk factors. Trauma to the proximal dorsal metatarsus, particularly over the digital extensor tendons, often precedes classical stringhalt and likely is an important factor in the development of this form. Months may elapse between injury and the onset of stringhalt.

Since 1884, most reports of bilateral stringhalt have implicated the common pasture weed *Hypochoeris radicata* (also known as flatweed, castear, cat's ear, or false dandelion). Most outbreaks occur in late summer or autumn among horses grazing drought-damaged pastures heavily infested with *H. radicata*. Cases often occur following weeks to months of grazing on suspect pastures. Interestingly, some affected horses are thought to have developed a taste for flatweed, to the exclusion of other forage. Several outbreaks have been associated with "true" dandelion (*Taraxacum officinale*), and one with mallow (*Malva parviflora*). Attack rates during bilateral stringhalt outbreaks are usually less than 50% but vary widely. Some attempts at producing bilateral stringhalt by feeding cut *H. radicata* to horses have been unsuccessful; however, recently, stringhalt was induced in a 6-month-old colt fed a daily average amount of nearly 10 kg *H. radicata* harvested from a pasture where the disease had occurred.

Bilateral stringhalt is a distal neuropathy primarily affecting large myelinated axons of the peripheral nervous system. The longest nerves in the body - namely, the recurrent laryngeal nerves and the peroneal and tibial branches of the sciatic nerve - appear to be most severely affected. This also explains why tall horses are more prone to the condition than young horses, ponies, or small native Chilean breeds. Shetland ponies have been affected however. The lesions of bilateral stringhalt are consistent with ingestion of a neurotoxin produced either by pasture weeds such as *H. radicata* or, less likely, by associated fungi.

It is likely that bilateral stringhalt and some cases of classical stringhalt result from interference with myotatic reflexes. The immediate cause of pelvic limb hyperflexion in bilateral stringhalt presumably is progressive degeneration of large myelinated axons in tibial and peroneal nerve branches including: α motor neurons to skeletal muscle, 1A and 1B sensory neurons from muscle spindles and Golgi tendon organs, and γ -efferents to muscle spindles. Classical stringhalt may be the final common sign for a variety

of insults: besides interference with limb reflexes, mechanical effects of adhesions involving the muscles and tendons of the digital extensors of the pelvic limb may be important as well as painful conditions of the hock or distal limb.

Pathology

In longstanding cases of bilateral stringhalt there is variable, often severe, atrophy of the muscles of the pelvic limbs, especially distally, and atrophy of the muscles of the larynx supplied by the recurrent laryngeal nerves. In peripheral nerves there are decreased numbers of myelinated fibres, perineural fibrosis, and accumulation of myelin debris. Evidence of nerve regeneration is usually found including regenerating nerve clusters, onion bulbs, and Schwann cell proliferation. Recurrent laryngeal nerves, branches of the sciatic nerves, and variably other nerves are affected with a proximal to distal gradient of severity.

Treatment

Care should be taken to identify sources of pain (e.g., arthritis, hoof abscess, recent hoof trimming) that might account for stringhalt like signs. Signs of stringhalt were blocked in one horse by intraarticular anaesthesia of the distal tarsal joints; use of intraarticular corticosteroids permanently resolved the problem.

Several skeletal muscle relaxants have been investigated in horses with bilateral stringhalt. Phenytoin, an inhibitor of voltage-gated sodium channels, gives partial to complete remission of signs in horses given 10–15 mg/kg orally, once or twice daily. Mephensin, which acts in the spinal cord to specifically inhibit polysynaptic reflexes, suppressed signs in a horse with chronic bilateral stringhalt but was ineffective in an outbreak of bilateral stringhalt. Baclofen, an analogue of the inhibitory neurotransmitter GABA had no effect in a horse with severe stringhalt. Taurine (10 mg PO q24 h) may help behavioral abnormalities.

Although the results of the procedure are unpredictable, surgical removal of the distal muscle belly and tendon of insertion of the lateral digital extensor effects a clinical cure in a proportion of horses with either classical stringhalt or bilateral stringhalt. Of 4 horses with classical stringhalt treated with lateral digital extensor myotectomy, 2 resolved, and the other 2 improved partially. The surgery was precluded in 2 other horses because of adhesions involving the tendon. Responses to a survey of veterinarians in Australia indicated that more than 50% of over a 100 lateral digital extensor surgeries had been successful in eliminating signs of stringhalt. Even more impressively, 11 of 13 horses with bilateral stringhalt were normal within 12 days of surgery. The surgery can be performed standing or in lateral or dorsal recumbency. An initial skin incision is made over the lateral digital extensor tendon immediately proximal to its junction with the long digital extensor and the tendon is isolated and exposed. A second incision is made over the muscle belly proximal to the hock and the muscle belly is dissected free of overlying fascia. The tendon is severed through the distal incision then the tendon is pulled through its sheath into the proximal incision by exerting traction on the muscle. The muscle belly is then incised 2 cm proximal to the musculotendinous junction. A modification of the technique, which may improve success rate, removes 7 to 10 cm of muscle. After the fascial and skin layers have been closed, a bandage is applied over the surgical site and maintained, with box-stall rest, for 2 to 3 weeks.

Prognosis

There is almost no information on outcomes for horses with classical stringhalt; however, it is commonly supposed that most cases persist although they may improve with time. Of one series of 4 cases that developed after proximal dorsal metatarsal trauma, one recovered, two improved, and one was unchanged for at least 6 months after onset of signs. Many cases of bilateral stringhalt recover normal gait and muscle mass if removed from toxic pasture. In a series of 70 cases followed over several years in France, 36 recovered in an average of 8 months, with 6 deaths, and 14 which still had stringhalt signs at least 2 years after onset. The few reported deaths are in horses that either are unable to stand or unable to move to sources of water and feed and are euthanized for humane reasons. Recovery times of 3 days to 3 years have been recorded with most horses taking 6 to 12 months. It is unclear to what extent athletic performance returns after clinical recovery from severe bilateral stringhalt. There is evidence that laryngeal dysfunction may persist beyond the time of recovery from gait abnormalities.

SHIVERS

“Shivers” is an inherited movement disorder predominantly of draft horses, warmbloods, Thoroughbreds, and occasionally other breeds. It begins between 2 and 10 years of age, with most cases occurring between 5 and 7 years, and is variably progressive over years. Tall horses (especially those greater than 17 hands) and males are overrepresented. Typical early signs include abnormal responses to lifting a pelvic limb and difficulties during backing. One or both pelvic limbs may be very difficult to flex manually and, even when the foot is successfully lifted, it may quickly be slammed back to the ground. Other affected horses hyperflex and abduct the limb when it is lifted. Backing often is accompanied by elevation of the tail and tremoring of the muscles of the tail and pelvic limbs. Most horses with shivers abnormally flex and abduct their pelvic limbs when forced to walk backwards while others are very difficult to force backwards and only move with extended stiff strides in both thoracic and pelvic limbs, usually refusing to move after several backward steps. There may also be facial grimacing and twitching during forced backward movements. With progression, hyperflexion also occurs during forward walking, especially during the first several steps after standing still or when changing direction. Long distance transportation and stress also may exacerbate clinical signs. Such horses usually are able to move normally at gaits above the walk, usually for years after the onset of clinical signs, and may be able to compete athletically. Very little information is available about the progression of clinical signs over the long term; however, it is clear that some horses remain relatively stable over time while others progress within 10 years to the point that they no longer can be ridden. Atrophy of muscles of the hindquarters and topline is a common feature of these chronic progressive cases.

Although shivers appears to be a genetic disease, the affected gene(s) has/have not been identified. Recently, a careful systematic study of the CNS of 5 horses with shivers has shown convincingly that the condition is associated with degenerative changes in the terminal portions of Purkinje cell axons in the deep cerebellar nuclei (DCN). The DCN are important components of the extended extrapyramidal system (see above) via their projections onto the upper motor neurons of the red and reticular nuclei. After many years of mystery, there now is a very clear relationship between discrete EPS; anatomic lesions in a structure relevant to the EPS and a clinically important movement disorder. Unfortunately, there is no specific treatment for shivers, although the low carbohydrate diet recommended for horses with PSSM and regular exercise apparently have helped some cases and avoidance of stress is critical.

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