Incomplete rupture of the gastrocnemius and superficial digital flexor muscles in a Quarter Horse stallion

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Case Description—A 16-year-old 500-kg (1,100-lb) Quarter Horse stallion was examined because of acute severe lameness involving the left hind limb.

Clinical Findings—Examination revealed signs of failure (concurrent flexion of the tarsus and extension of the stifle [femorotibial] joint) of the caudal component of the reciprocal apparatus. Results of radiographic evaluation ruled out fracture or joint injury as causes of the lameness. During the next 48 hours, the reciprocal apparatus on the left hind limb progressively deteriorated until the horse became non–weight bearing on the limb.

Treatment and Outcome—The horse wore a full-limb splint over a Robert-Jones bandage on the plantar aspect of the limb for 30 days. Thirty-four days after the initial injury, the horse had weak function of the reciprocal apparatus and limited ability to bear weight. Six days after removal of the splint, laminitis developed in the contralateral hind limb. The horse was managed with a sling for 5 weeks, during which time deep digital flexor tendon contracture developed. Eleven weeks after the initial injury, the stallion was discharged from the hospital and walking comfortably with a 1-cm-high block under the heel of the left hind foot.

Clinical Relevance—Incomplete failure of the caudal component of the reciprocal apparatus is an unusual injury that likely occurs during a fall with a hind limb extended under the body, resulting in forced extension of the muscle while it is engaged in contraction. Conservative management of this injury in a heavily muscled adult horse is possible. (J Am Vet Med Assoc 2006;229:1790–1794)

A 16-year-old Quarter Horse stallion weighing 500 kg (1,100 lb) was examined at Littleton Large Animal Clinic Equine Hospital with acute-onset grade 4/5 lameness of the left hind limb. The horse had fallen while jumping on a stage as part of an exhibition. Lameness was initially mild but became severe within 2 hours. During initial examination at the hospital, the horse would bear weight only on the toe. Mild soft tissue swelling was apparent caudal and proximal to the stifle (femorotibial) joint. The horse had a 4-cm-long laceration distal to the stifle joint and over the medial aspect of the tibia, and mild edema and SC emphysema were observed in this area. The emphysema appeared to be related to the wound; infection by gas-forming anaerobic bacteria was considered to be unlikely but possible. The horse had been immunized with a tetanus toxoid booster 8 months prior to injury.

Digital pulses in the affected limb were judged to be of the same intensity as in the opposite limb and were considered normal. Response to hoof testers in the affected limb was considered to be normal. No instability was detected in the skeletal structures of the limb, and no bony crepitus upon limb manipulation or ambulation was noticed. All palpable joints had a normal range of motion, with no evidence of increased effusion, heat, or pain during hyperflexion of other limb manipulation. Cutaneous sensation, conscious proprioception, and motor control were considered normal.

Radiographs of the stifle joint revealed no evidence of a fracture. The skin around the laceration was clipped and aseptically prepared, and procaine penicillin G (30,000 U/kg [13,636 U/lb], IM) and gentamicin (6.6 mg/kg [3 mg/lb], IV) were administered. Skin edges were desensitized with 20 mL of 2% mepivacaine injected SC. The wound was explored to ensure that it did not involve bone or synovial structures and was lavaged with a solution of 20 mL of procaine penicillin G added to 1 L of sterile saline (0.9% NaCl) solution. The skin was closed routinely, and a full-limb Robert-Jones bandage was placed on the limb extending from just below the stifle joint to the ground. The horse was hospitalized and prevented from lying down (and possibly propagating an incomplete fracture) by attaching the halter to an overhead wire. No analgesic medication was given so that the horse would protect the limb.

The following morning, the lameness was unchanged, although there was slightly more edema around the stifle joint. Radiography of the long bones of the left hind limb revealed no evidence of a fracture. Transrectal palpation was performed to assess the stability and symmetry of the pelvis, both of which were determined to be normal. However, as the horse moved the short distance from the radiology suite back to the stall, the lameness became more severe and signs of failure of the caudal component of the reciprocal apparatus were noticed. During attempts to bear weight on the affected limb, the tuber calcanei displaced distally as the tibiotarsal (hock) joint flexed concurrently with extension of the stifle joint (Figure 1). The metatarsophalangeal joint could be flexed and extended with the tarsus held in flexion, indicating disruption of the superficial digital flexor tendon or muscle. The common calcaneal tendon palpated normally, prompting suspicion that the disruption was more proximally located, in the gastrocnemius and superficial digital...
flexor muscles. A board-certified equine veterinary surgeon was consulted, and the prognosis with conservative management was considered to be guarded because of the size of the horse. Surgical repair was considered unlikely to be of benefit because there is no reliable way to reattach muscle to bone in a manner that enables weight bearing on the limb. There was also concern that any attempted repair would be unlikely to survive the horse's attempts to stand during recovery from anesthesia. A single dose of phenylbutazone (4 mg/kg [1.8 mg/lb], IV) was administered, and the horse continued to receive procaine penicillin G (30,000 U/kg, IM, q 12 h) and gentamicin (6.6 mg/kg, IV, q 24 h) because of the proximity of the skin wound to the stifle joint.

The horse remained hospitalized but was no longer tied to an overhead wire, given the absence of findings pointing to an incomplete fracture and also because of concern that supporting-limb laminitis and tendon or ligament failure would develop. The unaffected hind limb was bandaged for support, and frog support was incorporated into a foot wrap to ameliorate the effects of constant weight bearing. During the next 48 hours, the reciprocal apparatus in the left hind limb underwent progressive breakdown until the horse was completely non–weight bearing on that limb. If weight bearing was attempted, the tuber calcanei dropped toward the ground until loading returned to the contralateral limb.

A full-limb splint was fashioned from a hemicircumferential section of 10-cm-diameter polyvinylchloride pipe and placed over a Robert-Jones bandage on the plantar aspect of the limb. An orthopedic stockinet rolled into a donut shape was placed over the tuber calcanei. Elastic adhesive tape was used to affix the splint firmly to the limb from hoof to midtibial level. The top of the splint extended to the level of the tuber ischii. The top of the splint was padded, and elastic adhesive tape was applied from that point to the stifle joint in a continuous fashion. This had the effect of pulling the stifle joint caudally and pushing the hock cranially. With the splint in place, the horse immediately regained the ability to bear weight on the limb (Figure 2).

The splint was maintained for 30 days.

Figure 1—Photograph of a horse with failure of the caudal component of the reciprocal apparatus. Notice the soft tissue swelling at the stifle (femorotibial) joint and the distally displaced tibiotarsal (hock) joint. Cranial is to the left.

Figure 2—Photograph of the same horse with a splint applied to the caudal aspect of the injured limb. Notice that the horse is able to bear weight on the limb.
PO, q 12 h) was administered for the first 14 days, during which time the skin wound healed without complications. The splint and underlying bandage were changed every 2 to 4 days. The splint was modified frequently to minimize development of pressure sores, especially around the tuber calcanei. A window was cut from the splint in this area to relieve pressure, and a second full-length piece of polyvinylchloride pipe was attached behind the first to maintain the splint’s strength. With the splint in place, the horse was able to ambulate in the stall, either abducting or dragging the splinted leg, and would bear weight fully at rest. The horse rarely lay down during the night, but did become cast in the stall on 2 occasions and required assistance to rise. After the second episode of recumbency, the horse no longer tolerated the splint and would immediately lie down as soon as the splint was applied. It appeared that the horse was unable to sleep while standing because within moments of becoming recumbent, the horse had indications of being in rapid-eye-movement sleep and began twitching and vocalizing. During these episodes, the horse could be roused with a loud noise, which distinguished the signs from those of a seizure.

Thirty-four days after the initial injury, the horse had regained weak function of the reciprocal apparatus and a limited ability to bear weight. The stallion was maintained in a Robert-Jones full-limb bandage without the splint and received phenylbutazone (4 mg/kg, PO, q 24 h) for the next 6 days. During that time, the horse began shifting its weight on the hind limbs, and the digital pulses became more intense in the uninjured hind limb. Assessment of a lateromedial radiographic view of that foot revealed mild (2°) ventral rotation of the distal phalanx, consistent with supporting-limb laminitis. Pentoxifylline (7 mg/kg [3.2 mg/lb], PO, q 12 h) was administered, and a 1-cm-long strip of nitroglycerine gel was applied to the skin (with the hair clipped) overlying each neurovascular bundle to support venous dilatation in the plantar aspect of the pastern. The gel was covered with a light bandage that was left in place for 12 hours and removed for the remainder of the day. The frog in that foot was supported by application of compressed bandage material. In addition, the stall was modified to accommodate installation of a sling. Six days after removal of the splint, the horse was placed in a sling. The sling was maintained at a height such that the horse could choose to bear weight or relax and use the sling to fully support its weight. The sling was tolerated well; shortly after being placed in the sling, the horse slumped down into the sling and slept for approximately 1 hour, with the same REM sleep behavior that had previously been observed. Pentoxifylline and phenylbutazone were continued for 8 days after introduction of the sling, after which all medications were discontinued.

The horse remained in the sling for 5 weeks. After the first week, the sling was unfastened daily or every other day and the horse was permitted a short walk. Eight days after first being placed in the sling, contraction of the flexor tendons in the injured limb developed, resulting in the horse being unable to fully extend the digit of the left hind limb. During weight bearing, the heel of that foot did not contact the ground. A 4-cm heel-elevating pad was taped to that foot, which enabled the horse to bear weight more comfortably. During the next 3 weeks, the degree of heel elevation was gradually lowered to stretch the contracted tendons.

Eleven weeks after the initial injury, the horse was discharged from the hospital. At that time, the horse could walk comfortably with a 1-cm block under the heel of the left hind foot (Figure 3). The reciprocal apparatus appeared to have good function, although the tuber calcanei still rotated abaxially during limb loading, indicating that there still may have been some disruption of the medial head of the gastrocnemius muscle. No clinical signs of laminitis were apparent. The horse resided out of state and was transported home in the sling in a modified trailer. Discharge instructions to the owner included that the horse be confined to stall rest for an additional 30 days and be hand walked for 10 minutes twice daily. The trip home was made without incident. Four months after discharge, the owner reported that the horse was doing well and was being ridden, although gait deficits were apparent at the canter. The horse was used for limited breeding during the following season.

Discussion

Incomplete failure of the caudal component of the reciprocal apparatus is an unusual injury and is suspected to arise from a horse falling with a limb extended under the body, resulting in forceful extension of a muscle engaged in active contraction.23 For example, this injury could occur when a horse falls backward out of a horse trailer. Alternatively, it may occur during attempts to rise after a period of prolonged recumbency. E. The injury can be unilateral or bilateral. Tissue fail-
ure may occur at the site of partial insertion of the common calcaneal tendon on the tuber calcanei, at the musculotendinous junction, or at a more proximal site on the limb, where the gastrocnemius and superficial digital flexor muscles originate on the femur. The gastrocnemius muscle appears to fail before rupture of the superficial digital flexor muscle in most instances. The lateral head of the gastrocnemius and the superficial digital flexor muscle are most commonly affected. The characteristic limb position is usually caused by failure of the mostly tendinous superficial digital flexor muscle. This causes the tarsus to collapse into flexion during weight bearing, despite simultaneous extension of the stifle joint. The injury can progress with time, as hemorrhage and necrosis further weaken the damaged muscle.

Affected horses have acute, severe lameness accompanied by various degrees of soft tissue swelling. The degree of swelling is dependent on the severity of hemorrhage, which can be life threatening. When sufficient disruption of the musculature on the caudal aspect of the thigh has occurred, the characteristic gait and abnormal limb manipulations are strongly indicative of reciprocal apparatus injury. Reciprocal apparatus injury is indicated by the ability to flex the tarsus with the stifle joint in extension. Injury to the peroneus tertius muscle is generally not evident during the weight-bearing phase of the stride, unlike when there is injury to the gastrocnemius and superficial digital flexor muscles. Disruption of the superficial digital flexor muscle is confirmed by the ability to flex and extend the metatarsophalangeal joint with the tarsus held in flexion. Injury to the common calcaneal tendon is typically easy to detect with palpation. Blood flow to the extremity should be evaluated because traumatic injury to the femoral artery can compromise perfusion of the distal part of the limb. In addition, fibular neuropaxia may occur where the nerve courses between the lateral head of the gastrocnemius and the biceps femoris muscles. Radiographs are an important part of diagnostic testing because early detection of a fracture may alter the direction of case management.

Ultrasoundographic evaluation of this injury has been reported. Knowledge of regional anatomy and careful physical examination are helpful in localizing the site of injury. Ultrasound evaluation may confirm the location of the injury but is not necessary for accurate diagnosis. The greatest values of that imaging modality may be in obtaining prognostic information when complete disruption of the apparatus is suspected or for monitoring the progress of fibrous scar tissue formation.

Treatment of rupture of the caudal component of the reciprocal apparatus has been described. The goal of treatment is to return the affected limb to weight bearing while minimizing the distance necessary for bridging by fibrous scar tissue. Various techniques have been described, depending on the location of the injury and size of the horse. Surgical repair incorporating carbon fiber was described in a young horse with disruption of the common calcaneal tendon. External coaptation has also been used, with a cast placed from the foot to the midtibial level of the limb. Cast application carries the risk of pressure sore formation, especially at the tuber calcanei and dorsal aspect of the tibia at the proximal limit of the cast.

In another report, a 6-month-old 270-kg (594-lb) Warmblood with a muscle injury in the proximal portion of a hind limb was successfully treated with application of a Thomas splint-cast combination. This procedure involves application of a cast with incorporation of a metal bar that forms a ring around the thigh musculature in the inguinal region. The procedure requires general anesthesia. Weight is transferred through the bar to the cast, decreasing the potential for cast sores. In other reports, 3 horses were treated conservatively, 2 with successful outcomes. The successfully managed cases both involved 2-year-old horses in which the injuries healed after 12 to 16 weeks of confinement with no external coaptation. The third horse was a 4-year-old Quarter Horse that reinjured the limb 12 weeks after the initial injury, resulting in complete disruption of the superficial digital flexor and gastrocnemius muscles. That horse was euthanized. On postmortem examination, the heads of both muscles were torn from the femur and contracted distally, leaving a large fibrous cavity filled with serum and soft tissue debris. Another alternative to external coaptation is supporting the horse by use of a sling. The estimated time necessary for fibrous healing is ≥12 weeks.

The prognosis for horses with disruption of the caudal component of the reciprocal apparatus is guarded. Foals appear to be at particular risk of life-threatening hemorrhage when the femoral artery is involved. The prognosis is better with only partial rupture of the apparatus; horses with complete failure have a grave prognosis for survival. After survival of the initial injury, age, weight, and temperament each has an important impact on outcome, with younger horses of lighter body weight having a survival advantage. To our knowledge, successful conservative management of horses with rupture of the caudal component of the reciprocal apparatus has not been described in a heavily muscled adult horse. The splint described in the present report had several advantages: it was made of inexpensive, readily available materials, enabled frequent evaluation of the limb for pressure sores, and was easily modified when necessary. The splint enabled return of the limb to weight bearing, which decreased the likelihood and severity of flexor tendon contracture and supporting-limb laminitis. Disadvantages included the expense of bandage materials, cost of frequent evaluation, and the fact that the splint may have contributed to recumbent sleep deprivation. Combination treatment that includes splinting and use of a sling may yield the best results. Conservative management of this injury is possible for horses with temperaments that permit slinging.

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A. Elastikon, Ethicon Inc, Somerville, NJ.
B. Anderson Sling, Care for Disabled Animals, Potter Valley, Calif.
References


Selected abstract for JAVMA readers from the American Journal of Veterinary Research

Effects of ultraviolet radiation on 25-hydroxyvitamin D₃ synthesis in red-eared slider turtles (*Trachemys scripta elegans*)

Mark J. Acierno et al

Objective—To determine whether there are increased concentrations of 25-hydroxyvitamin D₃ in red-eared slider turtles (*Trachemys scripta elegans*) after exposure to UV radiation.

Animals—12 yearling turtles recently removed from aestivation.

Procedures—Turtles were randomly allocated to 2 groups (6 turtles/group). An initial blood sample was collected from all turtles for measurement of 25-hydroxyvitamin D₃ concentrations. Turtles of 1 group were then provided no supplemental lighting, whereas turtles of the other group were exposed to full-spectrum coil bulbs at a distance of 22.86 cm. The UV-A and UV-B radiation generated by the supplemental lighting was measured by use of a radiometer-photometer at weekly intervals. Measurements were collected 2.54 and 22.86 cm from the bulb surface. The study was continued for a 4-week period. At the end of the study, a second blood sample was collected from all turtles for measurement of 25-hydroxyvitamin D₃.

Results—Mean ± SD 25-hydroxyvitamin D₃ concentrations differed significantly between turtles provided supplemental UV radiation (71.7 ± 46.9 nmol/L) and those not provided UV radiation (31.4 ± 13.2 nmol/L).

Conclusions and Clinical Relevance—Appropriate husbandry recommendations for raising and maintaining red-eared slider turtles should include use of sunlight that is unobstructed by UV-B filtering material or provisions of an artificial source of UV-B radiation. (*Am J Vet Res* 2006;67:2046–2049)