Management of Tendon Disorders in Cattle

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KEYWORDS
- Tendon
- Congenital
- Acquired
- Laceration
- Avulsion
- Tenosynovitis

Tendon disorders are a recognized cause of locomotory dysfunction in cattle, but the prevalence of lameness caused by tendon injury presently is unknown. Survey studies estimating the incidence of lameness in dairy herds in the United States, Canada, and the United Kingdom have not identified tendon disorders as a major cause of lameness.\textsuperscript{1–3} However, one study indicated tendon involvement in 21% of limb lesions.\textsuperscript{4} Another study reported that muscle or tendon lesions accounted for 74% of upper limb injuries in the forelimb and 7.8% in the hindlimb.\textsuperscript{5} Tendon injuries causing loss of a production animal or a decreased level of production result in significant economic loss to the cattle producer. Tendon disorders may be congenital or acquired. Congenital abnormalities include lax tendons, contracted tendons, and displaced tendons. Acquired tendon disorders include lax tendons, contracted tendons, luxated tendons, tendinitis, lacerated tendons, avulsed tendons, ruptured tendons, and tenosynovitis.

CONGENITAL TENDON DISORDERS

Hyperextension Deformities

Flexor tendon laxity is generally the cause of hyperextension deformities in newborn calves. Such laxity occurs more commonly in calves born prematurely and in calves that are small for their gestational age. Acquired hyperextension deformities usually result from excessive weight-bearing caused by contralateral limb lameness or occur following removal of external coaptation after a prolonged period. Unilateral or bilateral hyperextension of the tarsus can be encountered in newborn calves following forced extraction. A rupture of the peroneus tertius causes the hyperextension of the tarsus. The gait is abnormal but it does not appear to be painful.

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Mild-to-moderate hyperextension commonly responds to limited exercise (myotactic reflex) that strengthens and tones the muscles, tendons, and ligaments. If exercise is not successful, some form of heel extension can be used to prevent hyperextension of the distal interphalangeal joint and keep the toe on the ground. The authors have used a thin wooden block glued to the hoof wall with methyImethacrylate acrylic (Technovit, Jorgensen Laboratories, Loveland, Colorado) to obtain heel extension. When methyImethacrylate has to be used on calves’ claws, the heat from the acrylic setting must be controlled by pouring cold water onto the surface of the acrylic. Otherwise the corium can be damaged.

**Flexural Deformities**

Flexural deformities occurring in a sagittal plane reflect an inability to achieve or maintain normal extension of the limb ([Fig. 1](#)). Because flexural deformities often involve more than one structure, it is useful to describe them in terms of joints affected, rather than in terms of the affected tendons and ligaments. Congenital contracted flexor tendon is a common defect in cattle and occurs in numerous breeds. Etiologic origins for contracted flexor tendons include inherited factors, in utero malpositioning, and overcrowding caused by the size of the fetus relative to the dam. Contracted tendons may occur with other congenital abnormalities, such as cleft palate, dwarfism, and arthrogryposis. A complete physical examination should be performed on the calf to rule out other problems before treatment is initiated for contracted tendons. Older cattle may acquire contracted tendons as a result of disease of the limb (eg, fracture or radial nerve paralysis, physisis).

The majority of contracted tendons in calves are observed within the first few days after birth. If one has reason to suspect a joint lesion as well as a tendinous lesion, radiographic examination may be useful before a prognosis is made and therapy is undertaken. Flexural deformities generally are found around the carpus or fetlock ([Fig. 2](#)). Flexural deformities are classified as mild (if the calves are able to walk on their feet but the heels do not contact the ground), moderate (if the dorsal aspect of the hoof breaks over a vertical plane perpendicular to the ground), or severe (if the affected animals are forced to walk on the dorsal aspect of the pastern, fetlock, or carpus). Often, nutrient or colostrum intake is not sufficient because the calves are unable to walk. Colostrum should be administered orally or plasma administered intravenously if the calf has difficulty walking. Also, unless adequate bedding is used or unless

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**Fig. 1.** Flexor tendon contracture in a Holstein calf causing hyperflexion of the metacarpophalangeal joints.
preventive measures are taken, rapid abrasion of the skin can occur from repeated trauma. Successful treatment of flexural deformities depends on the site and severity of the deformity and on the appropriate use of medical, physical, and possible surgical therapy. Treatment of congenital flexural deformities should be initiated soon after recognition of the problem, with the severity of the condition dictating how treatment should proceed. As the animal gets older, the contracted tissues become less responsive. Mild-to-moderate flexural deformities usually respond to physical therapy with manual stretching of the tendons during exercise. The authors commonly construct an extended toe shoe, using methylmethacrylate acrylic and a thin wooden block, to increase the tension on the contracted tendons during exercise (Fig. 3). Moderate cases are treated by using a bandage, splint, or cast and by providing analgesia using a nonsteroidal anti-inflammatory drug. Nonsteroidal anti-inflammatory drugs provide analgesia to the calf and are useful for decreasing the pain associated with the stretching of the contracted soft tissue caused by weight bearing, passive stretching exercise, splints, or casts. In one case, only one dose of oxytetracycline administered intravenously at 44 mg/kg was necessary for a short-term (96 hours), moderate decrease in the metacarpophalangeal joint angle of a newborn foal. The mechanism by which oxytetracycline exerts its effect is unknown but it is most likely associated to a muscle relaxant effect. To the authors’ knowledge, the effect of oxytetracycline on contracted tendons in calves has not been studied scientifically. However, we do not recommend the routine use of oxytetracycline at this high dose in cattle because of the risk of inducing renal failure. A lower dose of tetracycline has been used to avoid renal failure with some success if treated early in the process of the disease.

A firm limb bandage can induce relaxation of a calf limb. This may be because of the supportive and protective effect on the muscles, tendons, and ligaments. Bandages should be placed over the entire limb, with the calf sedated and placed in lateral recumbency. The toes should be left unbanded to support some weight and further stretch the tendons. Three layers of sheet cotton folded over provide adequate padding and support for young calves. This relaxation also can be accomplished by the constant tension or stretching (inverse myotactic reflex) produced by splints or casts in calves with moderate-to-severe contractual deformities. Daily or every other day splints can be changed and the leg examined. In the forelimb, a splint extending from the hoof to the elbow should be used. In a hindlimb, the splint is placed from the foot to the point of the hock. The splint should be placed on the palmar/plantar...
aspect of the limb. The splint can be fashioned from polyvinylchloride (PVC) pipe cut into a semitubular shape and should be padded well to avoid pressure sores. Splints can cause severe pressure sores and thus must be carefully monitored.

A cast may be necessary to provide more support, especially for calves with carpal flexural deformity. With the calf sedated and in lateral recumbency, a fiberglass cast is applied and allowed to harden as someone reduces the contracted limb into as normal a position as possible. The toes of the limb should be exposed so that the calf walks on the toes rather than on the cast. The cast should be removed in 1 week so that the limb can be examined. The cast can be reused as a bi-halved splint if necessary. The relaxation effect of bandages, splints, and casts often provides enough improvement to allow further gradual improvement with exercise.

Most flexural limb deformities correct with persistent nonsurgical management. Those that do not improve may benefit from surgery, but the results in severely contracted limbs are often disappointing, and these animals usually are sent to slaughter when they reach an acceptable weight. Calves with severe flexural deformities of the fetlock may be treated by tenotomy performed in the midmetacarpal or midmetatarsal region (Fig. 4) or proximal to the carpus if the carpus also is affected by a flexural deformity. With the animal anesthetized, all tendinous tissues under tension are severed.
through a small incision until the limb can be fully extended. If the tenotomy results in some relief, but complete extension of the limb is still impossible, severe trauma to the periarticular tissues may be necessary to achieve adequate extension of the affected limbs. Bandaging and splinting of the limb for 1 to 2 weeks might be required postoperatively. If excessive relaxation of the limb is obtained, the limb, including the foot, should be placed in a cast for 3 to 4 weeks until the tendons are reunited by fibroplasia.

**Arthrogryposis**

Congenital arthrogryposis is defined as a syndrome of persistent joint contracture present at birth. Arthrogryposis may afflict one leg, the hind or front legs, or all four legs, and has been reported in many breeds of cattle. Arthrogryposis includes more than one etiologic and pathologic entity. A hereditary congenital deformity in Hereford cattle characterized by arthrogryposis, kyphosis, torticollis, scoliosis, and cleft palate has been described. Teratogens indentified as causing arthrogryposis include plants and prenatal viral infections. Ingestion of lupines by pregnant cows between 40 and 70 days' gestation has caused various degrees of arthrogryposis with other associated congenital defects. Lupine toxicosis is related to high alkaloid content.

Arthrogryposis should not be confused with contracted tendons in which the joints are aligned properly and the legs are not rotated. Usually, joints of calves with contracted tendons can be extended with pressure or corrected surgically. In calves with arthrogryposis and crooked calf disease, the articular and osseous changes usually are permanent and become worse as the calf grows. In one retrospective study on arthrogryposis including 113 calves, 74% of the animals had only the forelimbs (carpus and fetlock) contracted; in 75% of cases, a cesarean section was needed because of dystocia. Predisposing factors to arthrogryposis were male gender, posterior intrauterine presentation, and double muscling. If untreated, arthrogryposis of the carpus usually is lethal in cattle. It usually results in skin necrosis over the carpus, septic arthritis, and septicemia. Surgical treatment is attempted to improve the animal's posture sufficiently for it to obtain slaughter weight.

Surgical treatment for arthrogryposis of the forelimbs has been published and consists of desmotomy and tenotomy of contracted penarticular soft tissues. Often, all structures on the palmar aspect of the carpus, except blood vessels and nerves, are transected. A cast is then applied for a minimum of 6 weeks.
Approximately 80% of these surgically treated animals can be kept until they reach normal slaughter weight. Because of a possible hereditary component, the authors do not recommend keeping these animals for breeding. When palmar carpal ligament transection has been performed, carpal hyperextension may occur in the postoperative period. If the palmar angulation between the metacarpus and radius is less than 100° before surgery, the prognosis is poor. In these cases, arthrodesis of the carpus may be attempted.\textsuperscript{10}

\textit{Spastic Paresis}

Spastic paresis is a progressive neuromuscular disease that occurs in dairy, beef, and crossbred cattle. Signs of spastic paresis usually appear at a few weeks to several months of age.\textsuperscript{11} Spastic contractions of one or both gastrocnemius muscles and superficial digital flexor (SDF) tendons lead to hyperextension of the hock. The affected leg is extended caudally and is advanced in a swinging motion. With progression of the disease, the foot often may not touch the ground, and gluteal muscle atrophy occurs. Palpation of the limb shows that the gastrocnemius muscle is hard and rigid, but flexion of the hock is not painful. The base of the tail often is elevated.

Initially, few if any systemic effects result from the condition. With its progression, however, the animal may remain recumbent for a longer period and lose weight. Calves often must be slaughtered prematurely. No consistent pathologic lesion has been identified in the peripheral musculature or nerves or in the spinal cord or brain of animals with spastic paresis. The functional disturbance may be due to an overactive stretch reflex present in the gastrocnemius muscles caused by overstimulation or lack of inhibition of motor neurons. Because spastic paresis is probably inherited to some degree, affected animals should not be used as breeding stock. Surgical treatment of spastic paresis may be indicated in selected animals, mostly either to allow the cattle to reach slaughter weight or to keep an animal for sentimental value. We recommend mandatory castration before surgical treatment of calves affected with spastic paresis.

Two techniques for correcting spastic paresis have been described: tibial neurectomy or transection of a portion of the gastrocnemius and SDF tendons.\textsuperscript{12,13} Partial or complete tibial neurectomy is aesthetically more pleasing. The procedure can be performed under sedation and epidural anesthesia or under general anesthesia with the animal placed in lateral recumbency with the affected leg uppermost. The tibial nerve is found via a lateral incision through the biceps femoris muscle. The tibial nerve is isolated and its different branches are stimulated electrically to evaluate the corresponding muscle contraction. A 3-cm long segment is excised from each of the two nerve branches to the gastrocnemius. Closure is routine. Only one leg should be operated on at a time to assess the efficacy of the procedure. Partial tibial neurectomy has resulted in good-to-excellent results in 131 of 138 (95%) calves.\textsuperscript{12} The authors have performed complete and partial tibial neurectomy on a large number of calves affected by spastic paresis. Although clinical improvement is obvious, the results are suboptimal, temporary (usually lasting 4 to 6 months), and often do not allow the calf to return to a level of productive performance intended by the owner. The expense of this procedure makes tibial neurectomy impractical.

Transection of a portion of the gastrocnemius and SDF tendons is performed after sedation, with the animal placed in lateral recumbency and with the affected leg uppermost.\textsuperscript{13} The leg is surgically prepared from the midmetatarsus to the stifle and 2% lidocaine is locally infiltrated over a 10-cm length proximal to the calcaneus and over the cranial border of the lateral aspect of the calcaneal tendon. The two tendons
of insertion of the gastrocnemius muscle (lateral and medial head of the gastrocnemius muscle) and half of the SDF tendons are transected for a length of 2 cm, approximately 6 cm proximal to the point of the hock. The subcutis is closed with a simple continuous pattern, followed by a layer of simple uninterrupted skin sutures of nonabsorbable monofilament material. A bandage is applied over the surgical site for 5 days, and the skin sutures are removed after 14 days. The immediate effect of surgery is that the hock becomes profoundly flexed and the metatarsus becomes nearly parallel to the ground. Fibrous unions generally develop between the tendon ends, and limb posture returns in 4 to 6 weeks. Spasticity often returns slowly over several months. The authors have performed complete or partial gastrocnemius tenotomy on a large number of calves. Although clinical improvement is obvious, the results are temporary, usually lasting 4 to 6 months, and often do not allow the calf to return to a level of productive performance expected by the owner. This procedure can easily be done in field conditions and may be preferred over tibial neurectomy because of the lower expense associated with the procedure.

**ACQUIRED TENDON DISORDERS**

Dairy breeds, feedlot cattle, and cattle maintained in confinement housing are commonly affected by acquired tendon disorders, and the incidence of lameness in dairy herds ranges widely. Lesions in dairy cattle occur most frequently during the early lactational period and in first-lactation heifers. Lesions may occur more frequently during the spring and summer. However, lameness caused by tendon injury seems uncommon in cattle. Because such injuries are less common, information regarding acquired tendon disorders in ruminants is limited. Injuries observed in cattle include tendon displacement, traumatic tendinitis, septic tenosynovitis, and tendon laceration, avulsion, or spontaneous rupture.

**Septic Tendinitis**

Septic tendinitis is most commonly associated with extension of digital sepsis, sublolar abscess, or sole ulcer (pododermatitis circumscripta, Rusterholz ulcer) to involve the deep digital flexor (DDF) tendon. Avulsion of the DDF from its insertion on the flexor tuberosity of the distal phalanx (P3) may result if sufficient necrosis of the tendon or underlying bone occurs. Septic tendinitis also may occur when degloving injuries involve the flexor or extensor tendons of the distal limbs. Degloving wounds are often associated with injury from wire fencing, farm machinery, metal siding on buildings, trailer accidents, and dog attacks. Treatment includes thorough surgical debridement, lavage, daily wound management, and systemic antibiotic and anti-inflammatory medication. Antibiotic selection should be based on results of microbial culture and sensitivity. In the authors’ experience, *Arcanobacterium pyogenes*, *Escherichia coli*, *Bacteroides* spp, and *Bacteriaceae* are the most commonly involved bacteria. For empiric therapy, procaine penicillin G (22,000 U/kg, intramuscularly [IM] or subcutaneously [SC], every 24 hours), sodium ceftiofur (2.2 mg/kg, IM, every 24 hours), or ampicillin trihydrate (10 to 22 mg/kg, IM/SC, every 24 hours) are the antibiotic treatments of choice when microbial cultures are not performed. If DDF tendon involvement is confined to a single digit, a wooden or rubber block (claw block) may be applied to the solar surface of the healthy digit to improve comfort and ambulation. We recommend that these animals be maintained in a restricted environment (stall or small pen) during convalescence (6 to 8 weeks). Also, the claw block should be removed before the animal is turned out to pasture to prevent damage to the tendons and ligaments of the healthy digit.
Prognosis for septic tendinitis is good for superficial wounds. Deep wounds causing extensive tissue necrosis or sepsis of adjacent synovial cavities (joints, tendon sheaths) warrant a more guarded prognosis.

**Tendon Laceration**

Tendon laceration is an uncommon cause of lameness in cattle and occurs most commonly when the cow falls onto or kicks a sharp object. The rear limbs are affected most commonly. Typically an open wound with contamination or infection is present at the site of tendon rupture. Management practices may be associated with the higher incidence of tendon lacerations among dairy breeds. Adult dairy cattle are maintained in a high-concentration environment and are often moved on concrete flooring. Concrete flooring requires frequent cleaning, which is often done using a tractor with a blade attachment. Therefore, dairy cattle are exposed to potential hazards on the farm. Feedlot cattle are also housed in concentrated environments with frequent exposure to farm machinery. However, feedlot cattle may be infrequently presented for treatment because of their lower perceived individual economic value.

Lacerations occur most commonly in a single hindlimb at the level of the midmetatarsus. Ultrasound examination of the involved tissues may be limited because of the pressure of an open wound and emphysema of the peritendinous tissues. Radiographs (survey, contrast studies) may be useful to determine if a joint or tendon sheath is involved and to evaluate for the presence of a foreign body.

**Tendon Avulsion**

In our experience, the most common tendon avulsion of cattle is avulsion of the DDF tendon from its insertion on the solar aspect of the third phalanx. Avulsion of the DDF tendon usually occurs secondary to sepsis of P3 and necrosis of the tendon insertion caused by subsolar abscess, sole ulcer, septic arthritis of the distal interphalangeal joint, or septic pedal osteitis. We also have observed avulsion of the calcaneal tendon from its insertion on the calcaneus secondary to septic apophysitis in calves. Septic apophysitis was presumably caused by hematogenous bacterial colonization. We also have diagnosed several animals affected with avulsion of the gastrocnemius muscle from its origin on the distal caudal femur. Traumatic tendon avulsion affecting the peroneus tertius muscle has occurred in calves immediately after removal of a full-limb cast. We have seen traumatic avulsion of the tendon of insertion of the extensor carpi radialis muscle in a calf after manual extraction for treatment of dystocia.

Management should be directed toward support of the limb and treatment of the inciting disease. Treatment may include stall rest and anti-inflammatory medication. Surgical debridement, lavage, and daily wound management is indicated for deep sole ulcer, subsolar abscess, and septic pedal osteitis. Because a septic process is often at the origin of the avulsion of the DDF tendon from the distal phalanx, a facilitated ankylosis of the distal interphalangeal joint is favored to stabilize the foot. Affected cattle should be confined to a small pen or a stall for 6 to 8 weeks. The prognosis for uniaxial DDF tendon avulsion is good if the cause of infection is treated.

A full-limb cast was used to treat a calf with avulsion of the tendon of insertion of the extensor carpi radialis muscle. The cast was removed after 21 days, and stall rest continued for 14 days. The calf made a full recovery, without complications. Avulsion of the gastrocnemius muscle may be treated using a Thomas splint to stabilize the limb, but a poor prognosis for return to productive soundness should be given for complete avulsion. Stall rest for 8 to 12 weeks is recommended for partial gastrocnemius muscle avulsion. The owner should receive a guarded to fair prognosis for the animal.
Tendon Rupture

Spontaneous tendon rupture is most commonly associated with breeding accidents, bull fights, or postpartum neuropathy and usually involves the gastrocnemius muscle-tendon unit. Spontaneous rupture of the gastrocnemius muscle usually occurs at the junction of the muscle fibers and tendon (Fig. 5). Direct trauma may cause rupture of the gastrocnemius tendon adjacent to the insertion on the tuber calcaneus. Flexor tendon rupture may occur secondary to septic tendinitis, necrosis, and sepsis of peritendinous tissues. Septic tendinitis often occurs from open wounds or degloving injuries. Also, rupture of the DDF tendon may occur secondary to septic pedal osteitis, septic arthritis of the distal interphalangeal joint, or septic flexor tenosynovitis.

Treatment of Tendon Disruption

Flexor tendon lacerations can be managed successfully in cattle by tenorrhaphy and external coaptation or by external coaptation alone. Economic costs associated with treatment and prolonged convalescence should be discussed with the owner before attempting therapy. Also, the owner’s expectation for long-term productivity should include the likelihood of persistent lameness.

Options for treatment of tendon laceration in cattle include stall rest, use of a wooden or rubber block on the healthy digit, cast application, tenorrhaphy, and corrective farriery (Fig. 6). The location of the lesion, individual tendon involvement, and concurrent injuries are important factors for treatment selection. Stall confinement may be adequate for incomplete lacerations and partial disruption of the gastrocnemius muscle or tendon. Application of a wooden block is useful when the branches of the DDF tendons (III or IV) to a single digit are disrupted. A full-limb or half-limb cast may be indicated for injuries disrupting the flexor tendons to both digits of the same limb. Stall rest, use of a wooden block, and external coaptation of the limb result in healing of the tendon by second intention (fibroplasia) and scar tissue formation. Flexor tendon laceration located distal to the hock may be treated with application of a cast that includes the foot and extends to the level of the hock but does not

Fig. 5. Simultaneous flexion of hock and extension of stifle in a recumbent cow suffering avulsion of the gastrocnemius muscle from its origin on the femur.
The fetlock may be flexed during casting to release tension from the tendons and allow closer apposition of the tendon ends. Alternatively, the limb may be cast in a normal, standing position. We recommend that the cast be maintained for 3 to 4 weeks longer than when a “flexed fetlock” cast is used. The fetlock must be lightly padded on the dorsal and palmar/plantar aspect to protect the limb from pressure-induced cast sores (ulcerations). Laceration of the calcaneal tendon may be treated with application of a cast that includes the foot and extends to the proximal tibia (level of the tibial crest). The portion of the cast spanning the hock must be thicker than the remainder of the cast to prevent the cast from breaking at this point. Reinforcing splints may provide a stronger structure and, if used, should be placed on the tension and compression sides of the limb. Thomas splints may be used to stabilize gastrocnemius muscle-tendon disruption. However, in our experience, the results have been poor. We prefer to use a full-limb cast when the disruption is close to the calcaneus.

Suture repair (tenorrhaphy) of transected tendons in addition to external coaptation achieves a more mature scar and a stronger scar-tendon unit more rapidly than does healing by second intention. The surgeon should have a good working knowledge of limbanectomy. Biomechanical tests of the various methods of tenorrhaphy have resulted in the recommendation that double- or triple-interlocking-loop or three-loop pulley suture patterns be used. The SDF tendon, DDF tendon, and suspensory ligament divide distally in cattle to provide one main branch to each digit. The bodies of the tendons in the metacarpal and metatarsal regions are wide and thin and present a challenge for anchorage of tendon sutures. In our clinical experience, the three-loop pulley suture pattern provides superior suture-holding power in damaged flexor tendons of cattle. However, we have not observed a clinically significant advantage using tenorrhaphy and external coaptation compared with external coaptation alone. Subtle benefits of tenorrhaphy may not be observed in cattle because they are not required to perform maximal exercise. Nylon, polydioxanon, and polyglyconate are the most common suture material used for tendon repair. However, no suture material nor any suture pattern currently in use can provide adequate breaking strength to allow ambulation without external coaptation. In horses, normal flexor tendons endure strain of approximately 5% when walking (without a rider).

Cast immobilization has been advocated for a minimum of 4 to 5 weeks based on biomechanical studies of tendon healing and on clinical observations. Supportive farriery also has been recommended after cast removal. Currently, the authors...
recommend external coaptation be maintained for a minimum of 60 days after complete transection of flexor tendons. After cast removal, a block may be used to elevate the heel and stall confinement should be continued for 2 to 4 weeks after cast removal. Elevation of the heel in the range of 40° to 70° decreases tendon strain in the DDF tendon but not in the SDF tendon or the suspensory ligament in horses. Heel elevation after cast removal is not required when a “standing conformation” cast has been used.

The prognosis for tendon rupture in cattle is considered good for injuries involving the SDF tendon alone. In our experience, the prognosis for survival and for long-term productivity of cattle with traumatic rupture of the digital flexor tendons (SDF, DDF, suspensory ligament) is fair to good. Ultrasound examination of the healing tendon may provide valuable information regarding treatment and prognosis. Treatment of gastrocnemius tendon rupture has only been recommended for young, lightweight cattle. In cases of complete disruption of the calcaneal tendon or gastrocnemius muscle, we provide a grave prognosis for cattle weighing more than 500 kg, and a poor prognosis for cattle weighing less than 500 kg. The prognosis for production soundness after disruption of the extensor tendons is considered excellent.

TENOSYNOVITIS (TENOVAGINITIS)

Based on research reported for horses, the tendon sheath has a structure that is distinctly different from that of diarthroidal joints. The synovial lining cells of the tendon sheath are fibroblastic in appearance and are composed of a single synovial cell type (diarthroidal joints have two distinct cell types).29 Also, the tendon sheath contains abundant blood vessels but few nerve fibers. Synovial fluid produced by the tendon sheath has a lower concentration of hyaluronic acid and a lower mucinous precipitate quality than those of diarthroidal joint fluid. However, the cellular constituents and protein concentration in tendon sheath fluid and joint fluid are similar. Cellular and protein changes in response to trauma and sepsis are also similar.

Pathologic lesions occur most commonly in the digital flexor tendon sheath. Stannan30 reported a that 10.7% of 766 cattle hospitalized suffered from tenosynovitis. The digital flexor tendon sheath originates from a point 6 to 8 cm proximal to the fetlock and extends distally to a point immediately distal to the coronary band. The tendon sheath is confined on its palmar/plantar surface by the palmar/plantar annular ligament of the fetlock, the palmar/plantar digital annular ligament (distal to the accessory digits or dewclaw), and the distal interdigital ligaments (proximal to the heel bulbs). Inflammation of the digital tendon sheath should be suspected when focal swelling of the palmar/plantar aspect of the pastern is observed concurrent with focal swelling extending proximally from the level of the dewclaws.

Inflammation of synovial structures may be caused by trauma, injection of irritant chemicals, immune-mediated synovitis, or sepsis. Inflammation and distension of the tendon sheath result in pain.30,31 Adhesions between the tendon and tendon sheath may result from sustained trauma or inflammation. Restrictive adhesions may cause recurrent pain and lead to decreased productive soundness. Two forms of tenosynovitis have been recognized in cattle: aseptic (traumatic, secondary synovitis, idiopathic) and septic (direct extension, iatrogenic, hematogenous). The authors have successfully treated various cattle affected with aseptic tenosynovitis using non-steroidal anti-inflammatory drugs, warm-water hydrotherapy (30 minutes, two to three times per day for 10 to 14 days), tendon sheath drainage and lavage (1-L 0.9% saline or lactated Ringer’s solution, once), pressure bandages (changed every 2 days for 7 to
10 days), and/or intrathecal sodium hyaluronate (20 mg, once). Selection of treat-
ment is based on severity, location of the involved tendon sheath, and economic
constraints.

**Septic Tenosynovitis**

Septic tenosynovitis is most frequently diagnosed in the digital flexor tendon sheath
but also commonly occurs in the tendon sheath of the extensor carpi radialis muscle.
Sepsis of the tendon sheath typically occurs as a result of extension of local sepsis
(such as with sole ulcer, a septic distal interphalangeal joint, a septic navicular bursa
or podotrochleosis, or a heel bulb abscess) or by direct inoculation (via penetrating
wounds, foreign bodies, or iatrogenic trauma from farm implements, such as a pitch-
fork or front-end loader). Septic tenosynovitis caused by hematogenous translo-
cation of bacteria (septicemia) is rare. Clinical signs include lameness (moderate to
non–weight-bearing), recumbency, decreased milk production, and decreased feed
intake. When standing, affected cattle may be reluctant to walk or may walk with
the limb abducted or adducted to shift weight to the unaffected digit. Purulent effusion
of the tendon sheath results in swelling proximal to the accessory digits (dewclaws).
Swelling in the pastern region is limited by the annular ligament of the fetlock, the dig-
ital annular ligament, and the proximal interdigital ligaments. The lateral portion of the
hindlimb tendon sheath is more frequently affected. Diagnosis of septic tenosynovitis
may include physical examination, synovial fluid collection for cytologic evaluation and
culture, and radiography. Insertion of a blunt probe through the wound or injection of
contrast material into the wound may facilitate diagnosis of septic tenosynovitis.

Treatment of septic tenosynovitis should include management of the inciting
disease and of the infected tendon sheath. Each digital branch of the DDF tendon
has its own tendon sheath, but the two sheaths communicate near their proximal
extent. Interestingly, septic tenosynovitis does not commonly occur in both tendon
sheaths concurrently. The excessive fibrinous response to intrathecal sepsis, typical
of cattle, may serve to localize infection to a single digital tendon sheath. Medical man-
agement alone (systemic antibiotics, hydrotherapy, protective bandages) is unlikely to
be effective because of the severity of the inciting disease and the excessive fibrin
deposition within the tendon sheath. This relationship was demonstrated for septic
arthritis in cattle when medical treatment successfully resolved the infection in 43%
of affected cattle and surgical treatment resolved the infection in 73% of affected
cattle. Antibiotics cannot effectively penetrate fibrin foci to achieve therapeutic con-
centrations. Effective treatment of septic tenosynovitis involves surgical debride-
ment and lavage of the affected tendon sheath (in valuable breeding animals) or
digit amputation (in commercial cattle or cattle intended for salvage).

Several techniques may be used for surgical debridement, drainage, and lavage of
the tendon sheath. Surgical exploration of the tendon sheath provides optimal access
for thorough debridement of the tendon sheath and tendon. Exploration is performed by
incising the sheath beginning at its origin proximal to the accessory digits and extending
distally to a point approximately 2 cm proximal to the coronary band. After debridement
and lavage of the sheath, the sheath may be closed primarily or an indwelling Penrose
drain, exiting proximally and distally, may be used to facilitate drainage after surgery.
The Penrose drain is removed approximately 5 days after surgery and a bandage is
maintained for an additional 5 days after the drain is removed. However, this technique
is associated with extensive tissue damage and risk of injury to the neurovascular sup-
ply to the distal limb. Dehiscence of the surgical wound is another potential complica-
tion because of the high motion occurring in the palmar/plantar aspect of the fetlock. We
do not recommend this technique for routine use. The tendon sheath is better left open if the tendons are necrotic and had to be resected.

In our experience, the treatment of choice for septic tenosynovitis without the necrotic tendinitis in cattle is surgical implantation of an active lavage system using a multifenestrated silicone rubber drain (Snyder Hemovac, Zimmer, Dover, Ohio). This procedure is best performed with the animal sedated and restrained in lateral recumbency on a tilt table. Intravenous regional anesthesia (lidocaine 2%, 20 mL) is infused distal to a tourniquet before surgery. We routinely administer sodium or potassium penicillin (1 million units) distal to the tourniquet after the anesthetic has been instilled. Before surgery, a wooden block is applied to the healthy digit to improve comfort and ambulation during the convalescent period. A needle is inserted in the tendon sheath to verify correct location. A 14-gauge needle is inserted into the tendon sheath proximally and distally to guide optimal placement of the stab incisions. Then, limited debridement is performed through a stab incision placed into the proximal aspect of the tendon sheath and a second stab incision placed into the distal tendon sheath. A large, curved forceps or clamp (Rochester-Carmalt forceps) is inserted from proximal to distal within the tendon sheath. The instrument is used to grasp the proximal tubing of the drain, and the drain is pulled through the tendon sheath. The drain is then sutured into place and the excess fenestrated portion of the drain is discarded. Drainage and lavage is performed by high-pressure infusion of sterile, isotonic electrolyte solutions into the drain and by allowing the fluid to exit distally around the end of the drain. We use a 60-mL syringe and three-way stopcock to achieve high-pressure lavage. The distal end of the drain is sutured closed to occlude the lumen and force the fluids to exit the drain into the tendon sheath. The drain is sutured to the skin proximally and distally and maintained under a sterile bandage between flushing. High-pressure lavage is performed once daily for 5 to 7 days, using 1 to 2 L of saline or lactated Ringer’s solution. Crystalline antibiotic solutions may be instilled into the drain and tendon sheath after each lavage or when the drain is removed. Many veterinarians add antiseptic chemicals (such as povidone iodine or chlorhexidine) to lavage fluids. However, research has shown that povidone iodine (concentration >0.2%) and chlorhexidine (concentration >0.05%) induce significant synovitis and may exacerbate intrathecal disease. No significant benefit was observed with use of 0.1% povidone iodine solution based on bacterial cultures and histologic evaluation in in vivo experimental models of septic arthritis in horses.

Optimally, the drain should be cultured at the time of removal and the results compared with initial microbial cultures. Systemic antibiotics and anti-inflammatory medication are administered concurrently. Ascending infection of the tendon sheath is a possible complication with this technique. Also, higher costs associated with placement of the lavage system and daily wound and bandage management limit the use of this technique. In our experience, a good-to-excellent prognosis for long-term productive soundness may be given with this technique.

Digit amputation proximal to the middle phalanx provides ventral drainage of purulent material and fibrin from the tendon sheath. Immediate relief from pain and swelling may be noted after surgery. Antibiotics should be administered for 7 to 10 days after surgery, but may be omitted if early salvage is performed. This treatment limits the productive longevity of the animal.

Antibiotic and Anti-Inflammatory Therapy

Treatment of cattle with antibiotic or anti-inflammatory drugs must be instituted with consideration for potential drug efficacy, toxicity, and residues. Many drugs commonly used in food animal practice are used at extralabel doses, routes, volumes per injection site, and frequency. The veterinarian is compelled to follow strict
guidelines (veterinarian–client–patient relationship) when electing to use extralabel drugs. The reader is referred to pharmacology texts and proper regulatory agencies for policies regarding the extralabel use of drugs and proper withdrawal times for meat and milk to avoid residue violations.

Optimally, selection of an appropriate antibiotic is based on in vitro microbial culture and sensitivity results. However, culturing bacteria from synovial fluid is often difficult. Therefore, empiric antibiotic selection may be elected when culture results are negative or because of economic constraints. When empiric therapy is chosen, antibiotic selection should be based on known, common pathogens involved in deep tissue sepsis in cattle and on antibiotics known to achieve adequate tissue distribution. Common pathogens isolated from septic musculoskeletal lesions in cattle include *A pyogenes*, *Streptococcus* spp, *Staphylococcus* spp, *Fusobacterium necrophorum*, *Bacteroides* spp, and coliforms. In the authors’ experience, the most common pathogens involved in septic arthritis and tenosynovitis in adult cattle are *A pyogenes* and *E coli*. Antibiotics of choice include penicillin, cephalosporins, oxytetracycline, and trimethoprim-sulfa combinations (age dependent). Extralabel use of fluoroquinolone antibiotics has been banned by the Food and Drug Administration (Center for Veterinary Medicine).

The authors routinely use intra-articular or regional intravenous antibiotic infusions distal to a tourniquet as an adjunct treatment for sepsis of deep tissues (for example, distal interphalangeal joint sepsis, tenosynovitis, or septic cellulitis of the distal limb). This technique is used to achieve high concentrations of antibiotics in synovial spaces or peripheral tissues. Crystalline antibiotic solutions may be infused immediately after performing local intravenous regional anesthesia. Limited scientific research is available on this practice in veterinary medicine. Recently, the serum and synovial fluid pharmacokinetics after a single dose of cefazolin were reported for cattle. Peak synovial fluid concentrations were achieved 30 to 90 minutes after antibiotic infusion. Currently, the authors maintain the tourniquet for 30 to 45 minutes after antibiotic infusion.

REFERENCES


