Orthopaedic Injuries in Small Ruminants

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Abstract

A wide variety of orthopedic injuries are seen in sheep, goats and camelids. Long lone fractures and infectious arthritis are most common and will be emphasized herein.

Fractures in Food Animals

Fractures involving the limbs are common in farm animals, are most commonly found in young stock, and often occur subsequent to trauma during dystocia or handling. The most common fractures diagnosed in food animals include metacarpus and metatarsus (~ 50 %), tibia (~ 12 %), radius and ulna (~ 7 %), femur (uncommon), humerus (< 5 %), pelvis (uncommon), and phalanges (rare).[3] Fractures of the axial skeleton (mandible, vertebra, ribs, pelvis) are found less commonly. Food animals are excellent patients for treatment of orthopaedic injuries because they spend a majority of time lying down, have a tremendous potential for bone healing, are more resistant to contralateral limb breakdown and stress laminitis, and usually do not resist having orthopedic devices on their limbs. The decision to treat a fracture in a food animal is made by considering the cost of treatment, the success rate, perceived or potential economic or genetic value of the animal, and location and type of fracture. Most owners will elect to pursue inexpensive treatment for fractures with a high success rate, but owners also often elect to pursue costly fracture treatment, even when the success rate is estimated to be poor, when cattle are perceived to have high economic or genetic potential.

Emergency Treatment and First Aid

A thorough physical examination should be conducted on all animals suspected of having a fracture prior to the decision for treatment. However, the patient first must be made safe from continued trauma. Often, injured cattle are recumbent when examined. The animal should be allowed to remain recumbent until the physical examination has been conducted and an initial fracture assessment done. Assessment of hydration, cardiopulmonary, and shock status is of utmost importance. Young calves may suffer life-threatening hemorrhage after femur fracture if the femoral artery has been lacerated. Multiple rib fractures may be life-threatening if they cause flail chest, pneumothorax, or hemothorax. Adequate colostrum ingestion by newborn calves is critical to pre-operative preparation of the patient and success of the procedure. If colostrum ingestion is unknown, serum IgG should be determined or total protein measured. Calves that are well hydrated and have a serum protein of less than 5.5 g/dl should be considered to have poor colostral antibody transfer and receive a plasma transfusion before attempting fracture repair.

Temporary stabilization of limb fractures may be performed prior to moving the animal or attempting to get the animal to stand. As a general rule, fractures below the level of the mid-radius or mid-tibia may be temporarily stabilized with splints or casts. In my experience, field stabilization of fractures proximal to this level should not be attempted. These efforts often result in the creation of a "fulcrum effect" at the fracture site and result in increased soft tissue trauma, damage to neurovascular structures, or compounding of the fracture. Cattle with these fractures should be carefully loaded into the trailer and allowed time to lay down before beginning transport. For these proximal injuries, cattle will protect the limb adequately for transport and any additional trauma that occurs is less severe than that which may occur as a result of the "fulcrum effect".

External coaptation for temporary stabilization of the fracture may be done by using two splints or a cast. Two boards or pieces of a large PVC pipe cut in half, placed 90 degrees to each other (e.g., caudal and lateral aspect of the limb), create a stable external coaptation. A padded bandage is placed on the limb, the splints positioned, and elastic tape applied firmly. Circular clamps (e.g., hose clamps) may be used to achieve firm placement of the splints on the limb. The injury should be centered within the coaptation with as much support proximal and distal to the injury as possible. All external coaptation devices should extend to the ground (to a level immediately distal to the sole of the hooves). For injuries distal to the carpus or hock, the splints should be placed to the level of the proximal radius or tibia, respectively. For injuries proximal to the carpus or hock and distal to the mid-radius or mid-tibia, the lateral splint should extend to the level of the proximal scapula or pelvis, respectively.

Principles of Fracture Management

Location of the fracture, presence of soft tissue and neurovascular trauma, closed or open fracture environment, behavioral nature of the animal, and experience of the veterinarian are important factors for considering type of treatment chosen. Fractures of the axial skeleton are often treated by stall rest alone, because external or internal fixation is not required. For fractures involving the appendicular skeleton, the following questions must be answered: 1) is treatment required, 2) can the fracture be acceptably reduced closed or is internal reduction required, 3) can the fracture be adequately immobilized using external coaptation alone, or is internal fixation, with or without external coaptation, required, 4) and what is the cost-benefit analysis.

Walking block for bovine digit

Cattle have two weight-bearing digits for each limb and, therefore, may stand on one digit during convalescence of the paired digit (e.g., phalangeal fracture). A wooden, rubber or plastic block (2.5 to 3.5 cm height and formed to the size and shape of the healthy hoof) can be applied to the sole of the healthy digit. The animal is confined to a stall or small pen for six to 10 weeks while fracture healing proceeds and the block is removed. Often, wooden blocks will become worn and removal is not necessary.

Casting

Half-limb casts (short casts) can be used for immobilization of phalangeal fracture and for distal metacarpal or metatarsal physis fracture. The cast is placed from a point immediately distal to the carpus or hock, extending to the ground and encasing the foot. The dew claws and top of the cast are padded, but only stockinette or foam resin padding (3M company) is placed on the remainder of the limb. Thick padding, placed along the entire limb, will quickly become compressed, leaving room for the limb to move within the cast and displacement of the fracture to occur. Full-limb casts are used for fractures occurring at or proximal to the mid-metacarpus or metatarsus, but distal to the mid-radius or mid-tibia. Full-limb casts are placed similarly to half-limb casts, but the bony prominences of the accessory carpal bone, styloid process of the ulna, calcaneus, and medial and lateral malleolus of the tibia must be padded.

Placement of the cast is facilitated by use of rope restraint, sedation, or anesthesia as needed. An assistant should help to maintain alignment of the limb during application, being sure to check the position of the limb in craniocaudal and lateromedial planes. Tension on the limb during casting may be achieved by placing wires through holes drilled in the hoof wall and applying tension. The holes should be placed such that the hoof is positioned in a normal to slightly flexed position. The thickness of the cast is usually based on clinical judgement. Casts six to eight layers thick may be adequate for calves less than 330 lb (150 kg) body weight, but adult cattle may require casts 12 to 16 layers thick. Casts used on the hind limbs must be made thicker because of stress concentration by the angulation of the hock. Incorporation of metal rods within the cast (two rods placed 90 degrees to each other) can increase the strength of the cast, but is only needed in the largest of patients. Newer fiberglass casting materials are more resistant to breaking and do not weaken when wet if sufficient cast material is used. Use of a walking bar ("U" shaped bar placed under the hoof and incorporated into the cast) will increase distribution of loading forces into the cast and away from the distal limb, but the foot should always be included in the cast.

Casts may be maintained in calves for up to six weeks without being changed. Scheduled cast changes at three week intervals may be required for rapidly growing calves or for calves that become lame during convalescence. Physeal fractures are usually healed within four weeks, but non-physeal fractures often require six weeks to reach clinical union in calves. Fractures in adult cattle may heal within eight to 10 weeks, but often require 12 to 16 weeks for clinical union to occur. Radiographic union of the fracture (defined as bone union with resolution of the fracture line) is not seen for weeks to months after clinical union (defined as sufficient bridging callus to allow weight bearing without additional support to the limb) has been reached.

Thomas splint and cast combination

Use of a Thomas splint and cast combination is appropriate for fractures distal to the elbow or stifle. The length of the splint should be measured while the animal is standing and by using the normal limb for measurements. An appropriate splint is chosen or constructed, and the patient is placed into lateral recumbency (rope restraint, sedation, and / or anesthesia). The fracture is reduced and a cast applied from the distal metacarpus or metatarsus to the level of the proximal radius or tibia. The splint is placed on the limb, the foot is attached to the base of the splint by drilling holes in the hoof walls and wiring the foot to the splint base, and casting tape is used to attach the cast to the splint frame. The limb cast should be firmly attached to the splint frame to prevent rotation of the limb along the splint during ambulation. The hoop of the splint must be firmly placed into the axilla or groin to allow maximal weigh transference, and, therefore, the hoop must be heavily padded. Cattle having a Thomas splint-cast must be assisted to stand for three to five days until they learn how to rise under their own power. Also, these patients must be checked several times daily to ensure that they have not laid down on top of the splint. Often patients are not able to rise after lying down on the splint, and life-threatening rumen tympanities may occur if they remain trapped for a prolonged period.

Transfixation pinning and casting and external skeletal fixation

Transfixation pinning and casting may be applied either as a "hanging limb pin cast" or as an external skeletal fixator. Hanging limb pin cast refers to placement of transfixing, or transcortical, pins through the bone proximal to the injury, followed by application of a full limb cast. The body weight is transferred into the cast by the pins, and transmitted through the cast to the ground. Therefore, the distal limb "hangs" inside of the pin-cast. Pin-casts also may be used for external skeletal fixation (ESF) by placing transfixation pins proximal and distal to the injury. The advantage of using pin-casts for ESF compared with hanging limb casts is that the fracture is more stable, the fracture fragments are not able to move within the pin-cast after the swelling within the cast resolves, and the pin-cast may not need to span adjacent joints (cattle less than 600 lb [300 kg]).

Pin selection is made based on body weight of the animal, size of the bone involved, and configuration of the fracture. Diameter of the pin should not exceed 20 % to 30 % of the diameter of the bone. Defects larger than 30 % of the diameter of the bone cause marked loss of the bone's resistance to torsion loading. In general, 3/32 to 1/8 inch (2.4 to 3.2 mm) pins are used in calves weighing less than 220 lb (100 kg), 1/8 to 3/16 inch (3.2 to 4.8 mm) pins are used in cattle weighing 220 to 660 lb (100 to 300 kg), 3/16 to 1/4 inch (4.8 to 6.4 mm) pins are used in cattle weighing 660 to 1,320 lb (300 to 600 kg), and 1/4 inch (6.4 mm) pins are used in cattle weighing more than 1,320 lb (600 kg). Pins should be placed in the bone such that they are separated by a minimum of four times the diameter of the pin (e.g., two 6 mm diameter pins should be placed a minimum of 24 mm apart). This will minimize the risk of the concentration of mechanical forces between the two pins ("stress riser effect"). Before pin insertion, a hole should be pre-drilled through the bone to accommodate the pin. This hole should not be less than 0.5 mm of the diameter of the pin (e.g., 2.7 mm pre-drilled hole for a 3.2 mm pin). Veterinary orthopedic pins, in general, are not designed to drill while being inserted. Therefore, significant thermal and mechanical injury occurs in the bone during insertion. Pre-drilling, using an orthopedic drill bit, will prevent or limit this injury.

For management of open fractures, daily access to the wound is desired. This may be accomplished by leaving a hole in the cast ("window cast") at the site of the injury, but, in my experience, this gives unsatisfactory access to the wound and is uncomfortable to the patient because the swelling in the limb becomes concentrated at the defect in the cast. Alternatively, metal or acrylic side bars may be used. These side bars must be made large enough to sustain the weight of the patient.

Internal fixation (plate, intramedullary interlocking nail)

Internal fixation of fractures has been done in cattle of high perceived economic value. In general, application of bone plates is not recommended for cattle younger than three months old. Calves less than three months old have thin cortices with limited holding power for bone screws. Recently, intramedullary interlocking nails have become available. These implants may prove to be useful for young cattle, and for management of fractures with historically poor success with bone plating (e.g., humerus fracture). Techniques for application of bone plates is similar to that for horses.

Closed versus open fractures

Overall, closed fractures without damage to the blood supply to the limb have a good-to-excellent prognosis for healing in cattle. Prognosis for success is less for older cattle or cattle of high body weight. Open fractures have a guarded prognosis for healing in cattle. The success rate depends on the severity of soft tissue damage, bone affected, age of the patient, duration and degree of contamination of the wound, and economic limitations placed on fracture management. Prolonged antibiotic therapy is indicated, and open wound management is preferable to enclosing the wound within a cast. Mature cattle are better able to overcome bone infection associated with open fractures than young calves. Often, mature cattle having an open metacarpal fracture are able to heal and return to productivity after thorough cleaning of the wound, administration of antibiotics, and application of a full limb cast. However, young calves with similar injury are prone to septic nonunion or delayed union.

Treatment and Prognosis for Specific Fractures

Mandible

Mandibular fractures occur after injury during correction of dystocia or because of direct trauma (e.g., being kicked). Fracture of one mandible may be treated by stall confinement and providing soft feed (e.g., silage or haylage, grass hay). Treatment of the mandible fracture is indicated if the patient is unable to or has difficulty eating. Bilateral mandibular fractures usually require treatment. Intramedullary pins placed from the rostral mandible to the caudal aspect of the body of the mandible provide adequate stabilization of fractures occurring in the rostral half of the body of the mandible. Fractures occurring caudal to the premolars and rostral to the ramus of the mandible may be treated by application of an external skeletal fixator or a bone plate. Fractures occurring in the ramus of the mandible may be treated by application of a bone plate. Fractures of the mandible have a good-to-excellent prognosis for healing. Presence of an open wound does not significantly decrease prognosis.

Vertebra

Vertebral fractures occur as a result of trauma during handling for vaccination or when mounting for breeding or in response to estrus. Vertebral fractures of the cervical, thoracic, or lumbar spine causing paralysis of the limbs have a grave prognosis, and euthanasia is indicated. Minimally displaced fractures associated with minor neurologic deficits may be treated by stall confinement. However, progressive neurologic deficits may be seen weeks to months after the injury because of compression of the spinal cord by fibroplasia or callus. Treatment of fracture of the sacrum or coccygeal vertebra may be sought for cosmetic reasons in show animals. Application of a four or five hole bone plate allows stable restoration of normal anatomy. These injuries are often associated with tail paralysis, and the prognosis for return to normal function of the tail is guarded. Use of bone plates is preferred to cross-screw fixation because the bone density of the sacral or coccygeal vertebra is insufficient for the holding power of lag screws.

Pelvis

Fracture of the ileum or sacroiliac junction are the most common pelvic fracture in cattle. These injuries occur because of falls during mounting or on slippery flooring. Fractures of the ileum or sacroiliac junction respond well to stall confinement. Occasionally, ileum fractures become open, with bone projecting through the skin. Infection rapidly becomes established and bone sequestration occurs. Surgical removal of the fracture fragment of the ileum is indicated when sepsis or debilitating lameness is present. Internal fixation of ileum fractures is rarely indicated, but may be requested for cosmetic reasons. These fractures may be repaired by application of a bone plate, but reduction of the fracture may not be possible when the fragment is severely displaced.

Humerus

Non-articular, minimally displaced fractures of the humerus are best treated by stall confinement. In cattle, open reduction and internal fixation of the humerus with bone plates often causes permanent radial nerve paralysis. Use of an intramedullary interlocking nail may allow rigid fixation with minimal risk of radial nerve injury. Prognosis for healing the fracture with stall confinement is good, but prognosis for return to normal productivity is guarded. Severely displaced or articular fracture of the humerus requires attempted internal fixation, but the prognosis is poor for return to normal productive use.

Radius and ulna

Closed fractures of the distal physis of the radius may be treated by a full-limb cast, and have a good prognosis for success. Fracture of the mid-radius and ulna requires use of a Thomas splint-cast, transfixation pin-cast, or bone plate. Prognosis for healing is good, but significant contralateral limb injury may occur in animals treated by Thomas splint-cast. Transfixation pinning and casting and bone plating have good-to-excellent prognoses, with minimal risk of permanent injury to the contralateral limb. Where applicable and economical, I prefer to treat fractures of the radius and ulna using transfixation pinning and casting.

Femur

Femur fractures most often occur in calves during forced extraction for dystocia. Femur fractures are occasionally found in adult cattle after falling during mounting or on slippery flooring. Femur fractures in mature cattle have a grave prognosis for success because of their body weight and an inability to reduce the fracture. Therefore, euthanasia is elected. However, some selected femur fractures may respond to stall rest for eight to 10 weeks. In calves, stack pinning of the femur has a good prognosis for success. Open reduction of the fracture is performed, and two to five intramedullary pins are placed into the femur. If large cortical defects are present, then an external skeletal fixator may be applied in addition to the intramedullary pins. These fractures are usually healed by six weeks after surgery. Sepsis is the most common reason for failure of fracture healing.

Tibia

Although fracture of the tibia has been seen as a result of forced extraction during dystocia, tibia fractures are usually caused by trauma. Fracture of the distal physis of the tibia may be treated with a full limb cast, but these fractures are uncommon. Fracture of the middle portion of the tibia may be treated by Thomas splint-cast, transfixation pinning and casting, or use of a bone plate. Thomas splint-casts have a good prognosis for bone healing, but have a high rate of injury to the contralateral limb. Transfixation pin-casts and bone plates have a good to excellent prognosis for healing, and minimal problems with contralateral limb injury.

Metacarpus and metatarsus III/IV

Fractures involving the metacarpus (MC) or metatarsus (MT) III/IV are the most common fractures to occur in food animals. These injuries often occur as a result of forced extraction during dystocia. Closed fracture of the distal physis of the MC or MT may be treated using a half-limb cast. Closed fracture of the middle portion of the MC or MT may be treated with a full-limb cast. Open fractures in mature cattle may be treated by thoroughly debriding, cleaning, and flushing the wound, applying a full limb cast, and administering antibiotics for 10 to 14 days. In valuable cattle and young calves, open fractures are best treated by use of an external skeletal fixator and daily wound care until the wound is healed. Bone sequestra are often associated with open fractures of the MC and MT. Bone healing may not occur until sequestra have been removed. If prolonged sepsis has been present, cancellous bone grafts may be required to facilitate bone union. Optimal sites for harvesting cancellous bone grafts are the wing of the ileum and the proximal tibia. Implantation of antibiotic-impregnated bone cement beads into a septic wound will provide prolonged local release of antibiotics and may accelerate resolution of osteomyelitis.

Phalanges

Closed fractures of the phalanges may be treated by application of a 2.5 to 3.5 cm height block to the sole of the healthy digit. Confinement to a stall or small pen is recommended for six to eight weeks.

Complications of Fracture or Fracture Management

The most common complications of fracture are sepsis, nerve injury, and vascular injury. The most common complications of fracture treatment are cast or splint sores, breakdown injury in the contralateral limb, and malunion. Septic non-union may occur from a combination of factors involved with fracture and fracture treatment. Nerve and vascular injury can be minimized by appropriate fracture immobilization prior to transporting the animal or achieving definitive fracture treatment. Sepsis can be minimized by close attention to detail, thorough cleaning of the fracture site, and selection of appropriate antimicrobial drugs. Microbial cultures should be performed on all open fractures where economic limitations are not severe. Bone cultures are preferred to wound cultures for selection of antimicrobial drugs. Malunion can be prevented by optimal closed reduction or by open reduction and internal fixation when closed reduction can not be achieved. Contralateral limb injury can be prevented by strict confinement of the animal during convalescence, frequent monitoring, removal of external coaptation at the earliest appropriate time, and client education for on-farm fracture patient management.

References

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