Repair of Fractures in the Field

David C. Van Metre[1], *DVM, DACVIM;* **David E. Anderson**[2], *DVM, MS, DACVS*
[1]*Animal Population Health Institute, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523*
[2]*Section of Agricultural Practices, Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66506*

Abstract

Effective fracture management in the field requires that the veterinarian evaluate multiple criteria in order to determine if the options for treatment applicable to the field setting are valid orthopedic treatment options, provide adequate patient comfort, and are cost-effective. The age, size, temperament, and intended use of the animal; location and physical characteristics of the fracture; experience of the attending veterinarian; the animal's environment during convalescence; and any economic constraints must be considered together in determining a prognosis and treatment plan. Treatment options commonly available for fracture management in ambulatory practice include stall confinement without external coaptation, cast application, and application of a Thomas splint-cast combination. Investigation of the etiology of the fracture may reveal opportunities for the veterinarian to educate farm or ranch personnel on methods of animal husbandry or handling that can potentially prevent future cases from occurring.

Résumé

La régie efficace des fractures sur le terrain exige que le médecin vétérinaire évalue plusieurs critères afin de déterminer si les options de traitement applicables sur le terrain sont des options orthopédiques valides qui permettent de donner un niveau de confort adéquat au patient et qui sont rentables. Il faut considérer ensemble plusieurs caractéristiques afin de déterminer le pronostic et le plan de traitement, comme par exemple l'âge, le tempérament et l'utilisation prévue de l'animal, la localisation et les caractéristiques physiques de la fracture, l'expérience du médecin vétérinaire traitant, l'environnement de l'animal durant la convalescence et toute contrainte économique. Les options de traitement qui sont disponibles habituellement dans la régie des fractures en pratique ambulatoire incluent le confinement à la stalle sans plaque visée externe, l'utilisation d'un plâtre, et l'utilisation d'une combinaison attelle de Thomas-plâtre. L'examen de l'étiologie de la fracture peut donner la chance au vétérinaire d'éduquer le personnel de la ferme ou du ranch sur les méthodes d'élevage des animaux et leur manipulation ce qui pourrait prévenir de nouveaux cas dans le futur.

Introduction

Fractures most commonly occur in young cattle, often resulting from trauma sustained during dystocia, handling, or trampling by adult cattle.[2,5,8] In some cases, optimal treatment entails transport of the animal to a veterinary referral hospital, where a greater variety of treatment options, such as internal fixation, exist relative to what might be accomplished on the farm or ranch. However, the option for referral is not always available, owing to economic or logistical constraints. It then falls to the attending veterinarian to determine if the external fixation methods commonly employed in ambulatory practice carry a reasonable prognosis for success for the case in hand, and if application of those methods is justified on humane and economic grounds.

Effective fracture management for cattle in the field setting requires evaluation of several important criteria. The animal's overall physical status, its intended use, the location and physical characteristics of the fracture, the animal's environment, the experience of the attending veterinarian, and economic factors must be considered together in order for the attending veterinarian to make the most appropriate decision for the animal and the producer.[2] The ultimate goal of the evaluation is to determine whether a treatment option is practicable in the field setting – specifically, confinement with stall rest with no coaptation, application of a cast, or a cast-splint combination - represents a valid option for treatment. If not, prompt euthanasia is indicated. While not always available, radiographs serve as a valuable diagnostic and prognostic tool. Radiographs aid in determining the degree of comminution and the potential for articular involvement, as well as provide an additional means of monitoring progression of healing. Detection of potential sequelae such as osteomyelitis or non-union is also facilitated by radiography.

Signalment and History

Consideration of the signalment (age, breed, gender, weight, production status, and intended use) and history is an essential first step in evaluation of cattle affected by fractures. The animal's age and size are important prognostic parameters, and a clear under-standing of the intended use of the animal is essential for cost-effective decision making. For example, although fractures may be potentially treatable in feedlot cattle, the costs of treatment - including labor for convalescent care - and the likelihood for significant delays in weight gain must be considered carefully in the economic analysis. In such instances, euthanasia is often warranted on economic grounds alone.

The history may reveal clues as to the etiology and location of certain fractures. While investigation of the etiology of a fracture in a given animal may not directly influence treatment or prognosis, if errors in animal husbandry, obstetrical techniques, or facilities management can be identified as a cause, future events that precipitate fractures can be potentially avoided. From a herd health perspective, therefore, investigation of the etiology of a fracture may represent a "teachable moment" – that is, an opportunity for the veterinarian to educate the farm or ranch personnel and initiate appropriate preventive measures.

For newborn calves with fractures, a description of the nature of parturition is necessary. Fractures of the metacarpus, metatarsus, and femur are common in calves delivered with assistance.[2,5,6,9] During assisted fetal extraction, direct compressive and tension forces applied by the obstetrical chains to the metacarpus or metatarsus can create fractures of the distal diaphysis of these bones. Calves may sustain femoral fractures during assisted fetal extraction while in either the anterior or posterior presentation; application of excessive force during 'hip lock' may have occurred during assisted delivery.[6] Evaluation of the dam's temperament is an essential component of managing fractures in calves. Fractious dams may be the cause of fractures in the calf; more importantly, if treatment is pursued, the calf may have to be weaned and bottle fed if confinement with the fractious dam is deemed too dangerous to allow. The labor and facility demands of such arrangements need to be considered before treatment is pursued.

For weaned juvenile cattle and adults, if the fracture occurred during animal handling or movement, a review of the circumstances might reveal opportunities for education or facility modification. If the injured animal has been recumbent for several hours, the duration of recumbency, the animal's position during recumbency, and the nature of the surface on which the animal has lain are important determinants of the risk of concurrent pressure myopathy of the down-side hind limb. Cattle with a history of being found in, or falling into, a position of sternal recumbency with both hind limbs in abduction (a 'splay-legged" posture) are prone to sustain coxofemoral luxation and fracture of the proximal femur.[4] Similar injuries may occur in cows and heifers mounted during estrus, and in "buller" feedlot cattle that collapse while being mounted. Abrasions or mud on the skin of the tail head, flanks, and ribs may be apparent when such animals are examined.

Physical Examination

A thorough physical examination is a vital component of the evaluation process. Hydration and cardiopulmonary status warrant careful evaluation, as restraint and sedation are often necessary for on-farm fracture repair.[2] The location of the fracture, status of the nerve and blood supply of the surrounding tissues, presence of compounded (open) fracture sites, the location and severity of concurrent orthopedic and soft tissue injuries must be evaluated during the physical examination.[2]

Newborn calves with fractures must be carefully examined for conditions that preclude the justification for treatment, such as serious congenital defects. Failure of passive transfer may result from failure to nurse colostrum in calves injured during or shortly after delivery. Calves affected by failure of passive transfer carry considerable risk for subsequent morbidity and mortality. Failure of passive transfer should be addressed by plasma or whole blood transfusion in calves for which treatment of the fracture is elected.[2] Conditions such as fracture of multiple bones and concurrent disease conditions may adversely influence the prognosis. In a Canadian study of calves with femoral fractures treated at a referral hospital, the presence of additional injuries, pneumonia, or diarrhea reduced the likelihood of a successful outcome.[6]

Adult cattle with fractures should also be examined for concurrent disease conditions, particularly those that might cause weakness or impaired mobility, such as periparturient hypocalcemia. When such conditions exist, fractures may occur secondary to falls sustained during attempts to rise or walk, and if uncorrected, will likely impair the chances of successful fracture treatment. The animal's temperament should be evaluated carefully during the examination. Cattle are generally considered to be good orthopedic patients, owing to their tendency to rest in recumbency for prolonged periods and their capacity to heal.[2,5,9] However, fractious cattle are prone to treatment failure owing to their potential for self-inflicted injury.

Treatment and Prognosis

Phalangeal Fractures

Fractures of the bovine phalanges are relatively uncommon and usually occur as a result of direct trauma.[2,5,9] Concurrent infection of surrounding soft tissues, bones, and joints is common with penetrating wounds. Phalangeal fractures that are minimally displaced are difficult to detect by physical examination alone, and radiographs may be necessary to document the presence of a fracture.[5] Phalangeal fractures complicated by soft tissue infection warrant a guarded prognosis.

Treatment of phalangeal fractures not complicated by soft tissue infection carry a good prognosis, with healing expected within six to 10 weeks with stall confinement.[2] Placement of a wooden, plastic, or rubber block on the sole of the sound digit should be performed to relieve weight bearing on the affected digit. The affected digit may be further stabilized by application of a bandage or a cast applied to the level of the mid-metacarpus or metatarsus, although the latter is rarely needed except in cases of unstable, highly comminuted fractures.[5] As for other bones, articular involvement in phalangeal fractures carries the potential for induction of osteoarthritis, resulting in chronic lameness.

Metacarpal and Metatarsal Fractures

The metacarpal and metatarsal bones III/IV are considered to be the most commonly fractured bones of cattle.[5] In calves, fractures of these bones may result from direct pressure from obstetrical chains during assisted delivery. Owing to the potential for circumferential damage to the surrounding soft tissues, fractures associated with obstetrical chains may include serious disruption of the blood supply to the distal limb.[9] Closed fractures with minimal comminution and an intact neurovascular supply to the distal limb carry a good prognosis, particularly in calves. The prognosis for open or heavily comminuted fractures, fractures associated with neurovascular damage to the distal limb, or fractures in heavier cattle warrant a guarded to poor prognosis.[2]

If the fracture is located in the distal physis of the metacarpus or metatarsus, a cast that extends to the proximal aspect of that bone can provide sufficient immobilization; however, for fractures of the diaphysis, the cast should extend above the carpus or tarsus to the proximal radius or tibia, respectively (i.e. a full-limb cast).[2] Application of a Thomas splint in addition to a full limb cast may be warranted for highly comminuted, unstable fractures.

Owing to the lack of surrounding soft tissues, metacarpal and metatarsal fractures carry significant risk of becoming open fractures. When detected promptly, open fractures can be successfully managed by thorough debridement and lavage of the fracture site. A sterile bandage should be applied to the wound, and the limb should be immobilized in a full-limb cast. Administration of long-term antimicrobial therapy is necessary. Depending on the degree of contamination of the fracture site, cast removal in one to three-week intervals may be required to allow for further debridement and bandaging of the wound site. Serial evaluation of the ease of ambulation in the cast, monitoring of rectal temperature and appetite, and repeated assessment of fracture stability during cast changes are necessary to judge the progression of healing. At the time of initial intervention, longstanding sepsis of an open fracture site warrants a poor prognosis for recovery. Relative to adults, calves have a greater tendency to develop nonunion of open fractures.[2]

Fractures of the Radius / Ulna and Tibia

Fractures of the distal physis of the radius/ulna and tibia may be treated by a cast that extends to just below the elbow and stifle, respectively.[2] Fractures of the diaphysis of these bones cannot be successfully treated with such casts because the proximal end of the cast will create a fulcrum effect on the fractured bone, thereby destabilizing the fracture site. A Thomas splint-cast combination allows weight on the fractured limb to be transferred from the ground to the inguinal or axillary areas and is considered to be the sole option for external coaptation of such fractures when treated in the field.[1-3] For diaphyseal fractures, a Thomas splint and cast combination can be used with success, although lateral deviation of the healed bone and pressure sores in the axilla and inguinal areas are potential complications.[1,3] Stall rest is required during the period of immobilization. The duration of time that the splint-cast combination must remain on the limb is variable, ranging from five to 13 weeks in one study.[1] The mean duration of splint-cast immobilization required for successful management of tibial fractures was 8.4 weeks (range, two to 14 weeks) in a Kansas study.[3] The prognosis for healing is good for closed fractures in calves and lighter cattle, but guarded for larger adults and for animals with open fractures.[1,3]

Fractures of the Humerus and Femur

Fractures of the humerus have been associated with heavy blunt force trauma, as might occur in bulls that fight during the breeding season. Owing to the close proximity of the radial nerve to the spiral groove of the humeral diaphysis, these fractures carry considerable risk of radial nerve damage; neurologic impairment in such cases can be permanent.[5,9] Radial nerve paresis or paralysis is characterized by an inability of the animal to extend the carpus and fetlock, and the elbow may be visibly displaced in a distal position (a "dropped elbow" appearance) relative to the normal forelimb. Owing to contracture of the heavy surrounding musculature, overriding of the fracture ends is often marked.[5,9]

Femoral fractures commonly occur in calves delivered by forced extraction during dystocia.[6] Concurrent, unilateral or bilateral femoral nerve damage may occur as a result of severe overextension of the proximal hindlimbs during extraction. In adults, femoral fractures may occur after falls or blunt trauma. As for humeral fractures, contracture of the heavy surrounding musculature can result in severe overriding of the fracture ends.

There are no external fixation methods that are appropriate for management of humeral or femoral fractures in the field. Although occasional return to function has been reported with several (12+) weeks of stall confinement, success with this form of management appears inconsistent; further, there is no easy way to identify beforehand which affected animals might respond well and which will develop fracture nonunion or complications resulting from prolonged recumbency.[5] For humeral fractures, stall rest may be most appropriate for the relatively uncommon cases that have minimal displacement of fracture ends[2] and no evidence of radial nerve damage.[5] However, considerable loss of condition can occur during convalescence, and if internal fixation is not an option, euthanasia is warranted for most cases of femoral or humeral fracture.[5]

Fractures of the Axial Skeleton

With important exceptions, minimally displaced fractures of the axial skeleton (pelvis, vertebrae, and mandible) are often manageable with stall rest.[2] Pelvic fractures commonly result from falls or injuries sustained when the animal is mounted by another animal; when located on the ileal shaft or tuber coxae, fractures often heal without complications.[2] Occasionally, sequestration and development of draining tracts necessitates surgical removal of the sequestrum.[4] Residual lameness can be expected if the fracture involves the articular surface of the coxofemoral joint or if displacement of the fracture ends is severe.

While unilateral mandibular fractures can be managed conservatively, bilateral mandibular fractures often require some form of internal or external fixation.[2] The presence of an open wound in cases of mandibular fracture does not greatly impact the prognosis.[2]

The prognosis for successful conservative management of vertebral fractures is grave if the associated neurologic deficits are severe.

Principles of Cast Application

For cast application, the animal is sedated, anesthetized, or otherwise restrained as necessary. Preparation of the limb for casting requires that mud and manure be washed or brushed off. The interdigital space should be cleaned and dried. Open wounds should be debrided, lavaged, and bandaged with sterile materials. Two-layer stockinette or foam resin cast padding should be applied to the skin. Application of excessive padding may actually promote the development of cast sores and impair fracture healing, as compression or slippage of padding may result in movement of the limb within the cast.[2] For casts that extend only to the proximal metatarsus or metacarpus (the "half-limb" casts), felt padding should be applied only to the dewclaws and to the top of the cast; these are typically taped in place over the stockinette. Holes can be cut in the stockinette and felt to allow the dewclaws to protrude through the holes in the felt padding. For full-limb casts applied to a forelimb, in addition to the dewclaws and top of the cast, additional padding is needed over the accessory carpal bone and styloid process of the ulna. For full-limb casts applied to a hind limb, the calcaneus and medial and lateral malleoli of the tibia must be padded, as well as the dewclaws and top of the cast.[2]

If desired, a wire saw can be placed within the cast to facilitate subsequent cast removal. Two lengths of obstetrical wire, each measuring approximately 1.5 – 2 times the length of the cast, are placed within plastic intravenous fluid tubing. One wire is then taped along the longitudinal axis of the limb on the medial side of the surface of the stockinette or foam cast padding, such that extra wire will protrude from the top and bottom of the cast. The second wire is taped in a similar fashion along the lateral aspect of the stockinette or padding. The cast is applied over these tube-encased wires, and the excess wires that protrude from each end of the cast are then wound into tight coils and taped securely to the external surface of the cast. When the cast is ready for removal, vise-grip pliers or obstetrical wire handles can be secured to each end of the medial wire. This wire is moved with broad, back-and-forth strokes to saw through the cast from the interior to the exterior. The process is repeated for the lateral wire, and the two halves of the cast are then easily removed. For very thick casts, however, the wires may heat and break before complete cutting is achieved, so this option is best reserved for casts applied to calves.

An assistant is often needed to maintain limb alignment during application of the cast. To maintain tension on the limb, an assistant can place traction on wires placed through holes drilled through the dorsal hoof wall. This typically creates mild flexion of the distal interphalangeal joint and helps to align the dorsal surfaces of the first and second phalanges with the dorsal surface of the metacarpal or metatarsal bones. Alternatively, in calves, adhesive tape can be applied lengthwise to the dorsal and palmar or plantar surface of the affected limb and then apposed together at the toes of the two claws to create a traction device. This tape can be held in traction by an assistant or secured to a fixed object to maintain the desired amount of tension on the limb. The foot should always be included in the cast.[2] Slight tension should be maintained on the fiberglass cast material as it is applied, such that a slight stretch is created in the material. Each wrap of the material should overlap its predecessor by approximately 50%.

The thickness of the cast is primarily determined by clinical judgment. Calves less than 330 lb (150 kg) may need a cast that is six to eight layers thick; however, 12 to 16 layers may be necessary for adult cattle.[2] Full limb casts on the hind limb must be made thicker in order to compensate for the tendency for the angle of the hock to concentrate forces in the middle of the cast, which can result in cast failure.[2] A U-shaped metal bar (a "walking bar") can be placed under the solar surface of the casted hoof and integrated into the cast to help dissipate force away from the distal limb during weight bearing. In heavy adults, incorporation of metal rods into the cast may increase the strength of the cast. Acrylic cement (e.g. Technovit®)[a] can be applied to the sole of the cast to limit the chance of the animal's hoof wearing through the bottom of the cast. Confinement to a stall or small corral is recommended to minimize the chances of rub sores developing beneath the cast. The date of the next veterinary examination or anticipated cast change can be printed in indelible ink or paint on the surface of the cast to aid in maintaining compliance with the treatment plan.

Cattle with casts should be monitored closely for changes in ambulation, increased time spent in recumbency, reduction in appetite, malodor, and fever, as these may indicate pressure sores, compounding of the fracture within the cast, or septic osteomyelitis. Casts can remain on calves for three to six weeks, depending on the rate of growth and the degree of comfort conferred by the cast.[2] In calves, clinical union of the fracture (determined by palpation and near-normal weight bearing with the cast removed) may occur in four to six weeks, while adult cattle may require three to four times as long to fully heal.[2] Radiographs of the affected bone may reveal persistence of a visible fracture line for several weeks after clinical healing has occurred.[2]

Principles of Application of a Thomas Splint-Cast Combination

Thomas splints for cattle are constructed from steel rods, with the diameter of rod needed dependent on the animal's body weight. As described by Adams and Fessler,[1] for Thomas splint-cast stabilization of fractures of the radius and ulna, body weight is related to steel rod diameter as follows: less than 500 lb (225 kg), 3/8 inch (0.95 cm); 500-1000 lb (225-450 kg), ½ inch (1.27 cm); and greater than 1000 lb (450 kg), 5/8 inch (1.59 cm). For Thomas splint-cast combinations used to stabilize fractures of the tibia, body weight is related to steel rod diameter as follows: less than 400 lb (180 kg), 3/8 inch (0.95 cm); 400-800 lb (180-360 kg), ½ inch (1.27 cm); and 800-1200 lb (360-540 kg), 5/8 inch (1.59 cm). For cattle weighing over 1200 lb (540 kg), 1-inch (2.54 cm) diameter steel conduit pipe is needed to construct a Thomas splint-cast combination for stabilization of tibial fractures.[1] The length of the apparatus should be pre-measured on the normal limb with the animal in a standing position. The distance from the base of the splint ring to the bottom of the splint is measured as the distance between the axilla or inguinal space to the bottom of the hoof. The ring should be well padded and of sufficient diameter to fit into the axilla or inguinal area without impinging on the shoulder or pelvis, respectively. The ventral third of the ring should be bent slightly inward (medially on the animal), such that this section of the ring rests securely within the axilla or inguinal area.

The animal should be sedated or anesthetized and placed in lateral recumbency with the affected limb on the up side. A stockinette, padding, and cast are applied to the affected limb, beginning at the level of the mid-metacarpus or metatarsus and extending proximally to the level of the proximal radius or tibia. The Thomas splint is then applied to the limb. The foot is attached to the bottom of the splint by wires passed through holes drilled in the hoof wall; acrylic cement can be used to further secure the foot to the splint. Casting material is then used to attach the cast firmly to the cranial bar of the splint frame. Casting material or tape can be used to cover the cranial and caudal bars of the splint in order to prevent the opposite limb from becoming entrapped between the splint bars.

Frequent observation of treated animals is necessary for several days after application, as the immobilized limb may become trapped beneath the recumbent animal, resulting in an inability to rise and secondary free-gas bloat.[3] Cattle with Thomas splint and cast combinations may need to be assisted to stand several times per day in the first week after application until the animal learns how to rise on their own.[1-3] The splint-cast combination may need to be changed during the period of immobilization because loosening of the cast can occur as swelling subsides.[1,3]

Salvage or Euthanasia?

For cattle that are ambulatory, otherwise healthy, and free from residues of animal health products, on-farm salvage for slaughter can be considered. During consideration of this option, consultation with the custom slaughter facility is warranted, because slaughter facilities may decline to provide this service out of concern regarding control of carcass temperature and hygiene prior to arrival at the facility. Given the animal welfare concerns and the risk of affected cattle becoming non-ambulatory, cattle with limb fractures that affect mobility and/or spinal injuries should not be transported to slaughter facilities, a position supported by the American Association of Bovine Practitioners.[7] The veterinarian can serve a valuable role in producer education on humane handling of disabled cattle.[8]

Conclusions

Effective fracture management in the field setting requires careful consideration of multiple patient, environmental, management, and economic factors. The veterinarian's primary goal is to determine whether the methods of fracture treatment commonly employed in the ambulatory setting are valid for the case in hand, given the attendant orthopedic considerations as well as the animal comfort, logistical, and economic concerns that apply. For certain fractures of the appendicular skeleton, effective and economical treatment of fractures can be achieved through cast application, application of a Thomas splint-cast combination, or stall confinement without external coaptation. Prompt euthanasia is indicated for fractures judged to be untreatable, and cattle with fractures that affect their mobility should not be transported to slaughter.

Endnote

[a]Technovit powder and liquid, Jorgensen Laboratories, Inc., Loveland, CO 80538

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