



Hanging Pin–Cast Technique: An Effective Approach to the Management of Tibial Fractures in Large Animals

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Tibial fractures are important orthopaedic conditions in large animals, particularly cattle, buffaloes, calves, sheep, and goats, due to the tibia's major role in weight bearing and locomotion. Their management is challenging because of substantial biomechanical forces, difficulties in prolonged immobilisation, and the need for specialised equipment and postoperative care. The hanging pin–cast technique is a minimally invasive and economical external skeletal support method that may be considered for selected tibial fractures, particularly in young animals. It combines a transosseous transfixation pin with a cast-supported suspension construct to provide skeletal anchorage and external immobilisation. The pin serves as a point of osseous support, while the cast helps resist bending and rotational forces, maintain fracture alignment, and limit interfragmentary movement. Partial suspension of the distal limb may reduce gravitational displacement and support secondary fracture healing. The configuration of the construct depends on fracture location and morphology, patient size, bone dimensions, soft-tissue condition, and available equipment. Unlike a conventional cast, the hanging pin–cast construct incorporates the pin into the load-transfer system; therefore, appropriate pin placement, secure bone purchase, cast integrity, and serial monitoring are essential. Careful case selection is necessary, considering fracture characteristics, skin and soft-tissue integrity, and the availability of adequate bone for safe pin placement. When appropriately indicated and applied, this technique may offer a practical alternative for managing selected tibial fractures in large animals.

Keywords: Tibial fracture, hanging pin–cast technique, transfixation pin, external skeletal fixation, large animals, fracture stabilisation, secondary bone healing.

Introduction

Tibial fractures are important orthopaedic conditions in large animals, particularly cattle, buffaloes, calves, sheep, and goats. The tibia is a major weight-bearing bone of the hind limb and contributes substantially to weight support and locomotion. Fractures may result from road traffic accidents, slipping on hard or uneven surfaces, falls, limb entrapment, or trauma during handling. Young animals may be at increased risk because of their activity levels and the relative vulnerability of developing bone. Management is challenging because of the patient's body mass, the difficulty of maintaining prolonged immobilisation, and the substantial axial, bending, and torsional forces imposed on the limb during standing and movement. Internal fixation with bone plates or intramedullary implants, and external skeletal fixation, may be indicated in selected patients; however, these options can require specialised equipment, surgical expertise, and intensive postoperative care. The hanging pin cast technique is minimally invasive, economical, and allows partial limb suspension, which reduces weight bearing on the fractured limb, promoting better alignment and healing. The hanging pin–cast technique is an external skeletal support method that may be considered for selected tibial fractures, particularly in young animals. It combines a transosseous transfixation pin with a cast or cast-supported suspension construct. When appropriately

selected and applied, the technique may help maintain fracture alignment, limit interfragmentary motion, and support secondary fracture healing.

The hanging pin–cast technique involves placement of a transfixation pin through an appropriate segment of bone distal to the fracture, followed by application of a cast that incorporates or suspends the pin. The precise construct depends on fracture location and configuration, patient size, bone dimensions, soft-tissue status, available equipment, and the clinician's chosen fixation strategy. The general biomechanical principle is to combine skeletal anchorage with external immobilisation. The transfixation pin provides a direct osseous point of support, while the cast contributes resistance to bending and rotational forces and helps maintain limb alignment. Suspension of the distal limb segment may also reduce gravitational displacement during healing. This technique should be distinguished from a conventional plaster cast. A conventional cast derives support primarily from its external shell and its interface with the limb. In a hanging pin–cast construct, the pin forms part of the load-transfer system. Therefore, pin position, pin–bone purchase, cast integrity, force distribution, and serial monitoring are critical. The technique is not appropriate for every tibial fracture. Its suitability depends on fracture morphology, soft-tissue and skin integrity, the availability of adequate bone for safe pin placement, and the patient's ability to tolerate the construct.

Selection of Suitable Cases

Appropriate case selection is fundamental to successful fracture treatment. Clinical examination and radiographic evaluation should be performed whenever possible to define fracture location, displacement, angulation, rotation, comminution, joint involvement, and the condition of the surrounding soft tissues. The technique may be considered for selected closed tibial fractures, particularly in young calves and other relatively small large-animal patients in which the limb can be adequately supported. Simple transverse, short-oblique, or other reducible fracture configurations may be candidates when acceptable alignment and sufficient mechanical stability can be achieved. Open fractures, heavily contaminated wounds, extensive soft-tissue injury, severe comminution, segmental fractures, and fractures with substantial bone loss require individual assessment and may necessitate debridement, more advanced fixation, or an alternative treatment plan. Fractures involving a joint, fractures without sufficient bone stock for safe pin placement, and injuries associated with major vascular or neurological compromise may be unsuitable for this technique. The clinician should also assess systemic health, body weight, nutritional status, housing, temperament, economic considerations, and the owner's ability to provide nursing care and attend follow-up examinations. These factors are general determinants of prognosis; the final treatment decision must be based on the individual patient and fracture.

Biomechanics

A. Load transfer

Body weight is transmitted through the cast and the ground. In a hanging-limb construct, the proximal transfixation pin anchors the cast to the skeleton and helps prevent the cast from slipping distally.

B. Bending resistance

The cast provides an external supporting structure that helps resist bending. However, a single proximal pin does not independently eliminate bending at the fracture.

C. Rotational control

Tibial fractures are exposed to rotational forces during weight bearing. Pins placed in both the proximal and distal fragments, incorporated into the cast, provide more direct control of relative movement and rotation than a conventional hanging-limb construct.

Principles of Application

The procedure should be performed by a veterinarian with appropriate orthopaedic training, using suitable restraint or anaesthesia, aseptic technique, and imaging support when available.

The following stages describe general principles rather than a universal operative protocol. Pin diameter, insertion site, orientation, reduction method, and cast configuration must be determined for each fracture.

1. Clinical examination and diagnosis: The affected limb is assessed for swelling, abnormal mobility, pain, wounds, distal limb perfusion, and neurological function. Radiographs are used to characterise the fracture and plan reduction and fixation. Additional injuries and systemic conditions that may influence anaesthesia, treatment selection, or recovery should also be identified.

2. Fracture reduction: The fracture is reduced to an acceptable alignment, with attention to length, angulation, rotation, and apposition. The required reduction method depends on fracture configuration and may involve controlled traction, manipulation, or assistance with positioning. The acceptable reduction target is case-specific and should reflect the mechanical and biological requirements of the fracture.

3. Pin placement: A pin of appropriate diameter is inserted through a suitable region of bone, avoiding joints, major nerves and vessels, and vulnerable soft tissues. Pin diameter, orientation, and location should provide adequate purchase and construct stiffness while minimising iatrogenic bone and soft-tissue injury. Inappropriate placement may cause pin loosening, pin-tract infection, thermal necrosis, neurovascular injury, or propagation of the fracture. For a conventional hanging-limb pin-cast construct, the transfixation pin is placed through the proximal tibial fragment, above the fracture, and its projecting ends are incorporated into the cast. The distal limb is enclosed in the cast, allowing the cast to hang from the pin. A commonly described principle is to select a pin core diameter around 20–30% of the bone's diaphyseal diameter, subject to the requirements of the particular fixation system. However, the terminology is not used uniformly in all veterinary references. Some constructs described as transfixation pin casts use pins in both fracture fragments. Therefore, the exact configuration must be specified when describing the technique. Direction should be Transverse, passing mediolaterally through both cortices, with careful attention to the local anatomy and safe access. Both ends of pin project through the soft tissues and are incorporated into the cast framework.

4. Cast application and support: The cast is applied to provide immobilisation and to integrate securely with the pin-supported construct. Adequate padding protects the skin and reduces the risk of pressure injury. The cast should distribute load without excessive focal pressure, vascular compromise, or interference with adjacent joints and soft tissues. Where practicable, the design should permit inspection of the pin sites and distal limb. Cast extent: Typically from the stifle region to the sole of the hoof for a full-limb construct. The precise insertion point cannot be safely specified as a single fixed distance for every animal. It depends on the animal's size, fracture location, bone diameter, and available bone stock. Cast extent Typically from the stifle region to the sole of the hoof for a full-limb construct. The precise insertion point cannot be safely specified as a single fixed distance for every animal. It depends on the animal's size, fracture location, bone diameter, and available bone stock.

5. Final assessment: Following application, limb alignment, construct stability, cast fit, distal perfusion, and pressure points are reassessed. Radiographs should be obtained when possible to confirm the final reduction and implant position. The owner should receive specific instructions regarding housing, hygiene, activity restriction, analgesia, follow-up, and signs of complications requiring urgent veterinary evaluation.

Postoperative Care and Monitoring

Postoperative management is integral to treatment success. The animal should be maintained in a clean, dry, well-bedded enclosure that permits safe standing and recumbency. Slippery flooring, uneven surfaces, and uncontrolled activity should be avoided. Permitted activity should be determined by the stability of the construct, fracture healing, and serial veterinary assessment rather than by a general schedule.

The cast and pin sites should be inspected regularly for swelling, discharge, malodour, loosening, skin irritation, or other evidence of pin-tract or soft-tissue infection. The distal limb should be evaluated for temperature, swelling, sensation, and circulation. Increasing pain, sudden deterioration in weight bearing, abnormal limb position, cast damage, or new instability may indicate a complication.

Cast changes or modifications should be performed when clinically indicated. The cast should not become wet, excessively loose, or structurally damaged. Owners should not tighten the cast, manipulate the pin, or administer medication without veterinary direction. Analgesia should be prescribed according to the patient's clinical status and an appropriate veterinary treatment plan. Antimicrobial therapy may be indicated for open injuries or confirmed infection but should not be used routinely without a specific indication. Adequate nutrition, hydration, and nursing care support recovery.

Serial radiographs can assist in assessing alignment, callus formation, and progression towards fracture union. The timing of cast and pin removal should be based on clinical stability and radiographic evidence of healing, not on a fixed interval. Premature removal may result in loss of alignment or refracture, whereas unnecessarily prolonged immobilisation may contribute to joint stiffness, muscle atrophy, and pressure-related injury.

Advantages of the Technique

The hanging pin–cast technique has potential advantages in appropriately selected cases. It combines external immobilisation with skeletal anchorage and may provide greater control of fracture alignment than an unsupported limb cast in suitable fracture configurations. It may also offer a practical option when internal fixation or more complex external skeletal fixation is unavailable, unaffordable, or disproportionate to the patient's circumstances. Because the construct is external, pin sites, the distal limb, and the cast can be assessed directly, although this does not eliminate the need for regular veterinary monitoring.

Young animals often have favourable fracture-healing potential, and an appropriately designed external fixation construct may achieve satisfactory results when reduction, stability, and nursing care are adequate. In selected cases, the technique may also avoid extensive surgical exposure of the fracture site and thereby reduce additional disruption of the fracture biology.

These are general potential benefits, not evidence that the technique is universally superior to plate fixation, intramedullary fixation, or other external skeletal fixation systems. The preferred method for an individual patient depends on fracture morphology, patient size, soft-tissue condition, available expertise, resources, and the anticipated functional outcome.

Limitations and Possible Complications

Potential complications include pin-tract infection, pin loosening, cast slippage, pressure sores, distal limb oedema, loss of alignment, delayed union, non-union, malunion, and refracture. Inadequate construct stiffness may permit excessive interfragmentary motion, whereas excessive cast pressure may compromise skin and soft-tissue perfusion. The body weight of adult cattle and buffaloes imposes substantially greater mechanical demands on fracture fixation than does the weight of a young calf. Consequently, a construct that may be appropriate for a calf cannot automatically be extrapolated to a mature bovine patient. Severe comminution, unstable fracture configurations, inadequate distal bone stock, and extensive soft-tissue injury may require alternative or more robust fixation strategies. Outcome also depends on owner compliance and the quality of postoperative care. Failure to maintain a clean enclosure, monitor the cast and pin sites, attend reassessment appointments, or restrict inappropriate activity can compromise fracture healing and patient welfare.

Conclusion

The hanging pin–cast technique is a potentially useful external fixation option for selected tibial fractures in large animals, particularly appropriately selected young calves. Its effectiveness depends on accurate diagnosis, case-specific treatment selection, satisfactory

fracture reduction, safe transfixation pin placement, appropriate cast construction, and diligent postoperative monitoring. No single fracture-management technique is suitable for every patient. General orthopaedic principles should guide assessment, but the final decision must account for the individual fracture pattern, patient size and health, soft-tissue condition, welfare considerations, available resources, and expected functional recovery. When these factors are favourable and follow-up is consistent, the hanging pin–cast technique may provide a practical and cost-conscious option for fracture management in large-animal practice.