

CHAPTER 14

PRINCIPLES OF TREATMENT OF FRACTURES AND LUXATIONS

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FRACTURES

PRINCIPLES OF TREATMENT

The ideal objective of fracture treatment is to provide a completely rehabilitated patient as quickly as possible. Successful fracture treatment comprises a perfectly aligned bone of full length that has solidly united joints that are freely movable to their fullest range, and musculature, innervation, and integument surrounding the site of the previous fracture that are completely normal. This idealized concept can rarely be achieved in a clinical situation. It is important that the surgeon strive to meet these criteria using all avenues of treatment by means of operative and nonoperative management of the fracture. [\(1.4\)](#) The objectives to be strived for include the following:

1. Sufficient reconstruction or restoration of normal form to meet the requirements expected of the limb
2. Immobilization of bone fragments until fracture healing has occurred
3. Mobilization of all joints involved during the process of fracture healing to prevent joint stiffness, fracture disease, and muscle atrophy. (The recent literature tends to substantiate the value of early passive motion before active motion can begin. [\(5\)](#))
4. Rehabilitation of the patient within a reasonable time, allowing the animal to continue at the level of service at which it functioned previous to the injury

From the objectives it is clear that even for the same fracture the type of treatment needed may vary from animal to animal. The racing sled dog exhibits a greater need for function than does the 12-year-old house pet. The amount of function lost by the older animal can be considerable and still allow for maintenance of performance at the preinjury level. The racing sled dog cannot afford to lose function, since this prevents a return to the level of preinjury function.

Depending on the fracture, one animal might be treated in a cast or splint, whereas another animal would require open reduction and internal fixation. No hard and fast rules can be given in all cases for a method of optimal treatment. Treatment regimes suggested in this textbook should be evaluated in light of the needs and abilities of the readers to optimally treat their patients.

METHODS OF MANAGEMENT

Fracture management can be classified according to the type of method used to achieve bony union. This classification is given below:

Closed reduction with external fixation such as a cast or splint

Open reduction without internal fixation, with reduction maintained in a cast or splint

External skeletal fixation in which reduction may be either open or closed and immobilization of the bone is maintained through the use of pins, clamps, and sidebars

Open reduction with internal fixation, such as intramedullary pins or plate and screws

Closed reduction with internal fixation: rather than making the exposure in the fracture site, an incision is made through the skin allowing introduction of the internal fixation device, for example, closed intra-medullary pinning or Kuntscher nailing

These modalities of treatment constitute the majority of cases treated in small animal orthopaedics.

Occasionally an animal is presented that does not require reduction or fixation, but a reasonable end result is still anticipated. Such cases, for example, occur with the pseudohyperparathyroidism associated with high-phosphorous-low-calcium diets. Although these cases are less common today than they were 10 years ago, they are still seen with some frequency in a large clinic. Often the dogs are presented with so many fractures that it is impossible to attempt immobilization with internal or external fixation. Many of these animals can be treated with cage rest and a change of diet, resulting in rapid consolidation of these many pathologic fractures. The overzealous treatment of this condition is

contraindicated, since it seems to respond with minimal management changes.

CLOSED REDUCTION

Closed reduction, usually with external fixation in the form of a cast or splint, can be accomplished in many fractures seen in small animal orthopaedics. The technique is used whenever a fracture can be reduced to the point at which the displacement is not more than one half the width of the diaphysis of the broken bone. Axial and rotational alignment should be correct, and the fracture should be inherently stable after reduction so overriding does not occur when the animal is placed in a cast or splint. If these criteria are met, the animal's fracture can be safely treated with external fixation. One additional problem associated with casting and splinting is immobilization of joints above and below the fracture site. Although it has been shown by Sarmiento that it is unnecessary to immobilize the joint above and below the fracture site, it is often advantageous to do so to maintain stability at the fracture site, thus initiating fracture healing.⁽⁶⁾ If immobilization of the joint above or below the fracture site will cause limitation of joint movement following fracture healing, other forms of fracture treatment should be considered. The most common fracture treated with closed reduction and cast or splint immobilization in our clinic is that of the radius and ulna, followed with less frequency by the tibia. The humerus and femur are treated with closed reduction and external fixation less commonly. Metacarpal, metatarsal, and other shorter bones can also be immobilized in a cast or splint after reduction.

Closed reduction may be indicated for physeal fractures of the Salter type I and II classifications.

Contraindications for closed reduction and external fixation are unstable fractures that cannot be reduced or are overriding and have uncorrectable rotational or angular deformities. Closed reduction is also contraindicated for fractures that when immobilized through external fixation in cast or splints may cause joint stiffness or fracture disease.

If closed reduction is planned, it is important that it be done as soon as possible following the injury. Although it is important to ascertain that the dog is in stable condition before anesthesia, it is also important to obtain the closed reduction before there is sufficient swelling and hematoma formation to immobilize the fragments. Muscle spasm resulting in overriding and shortening as well as hematoma formation, which causes swelling, occur quickly following injury.

Faster and more adequate reduction with less soft tissue trauma can often be accomplished if gentle traction is applied first. Fractures of the radius and ulna, for instance, are often treated by suspension of the limb with gentle traction for 10 to 15 minutes prior to closed reduction. This helps stretch the muscles involved without causing the secondary trauma associated with manipulation. Whenever closed reduction is accomplished, the leg should be prepped in a standard fashion as would be done for an open reduction, and the closed reduction is carried out in a sterile manner using cap, mask, and gloves. If by chance a closed fracture becomes an open one through manipulation, the risk of contamination and infection is decreased considerably and the wound can then be managed appropriately. The reduction itself is usually accomplished after flexing the elbow by toggling bone ends together and then reestablishing the axis of the bone with proper rotation. Flexion of the elbow releases some tension of the extensors of the forearm, making reduction easier. All closed reductions should be checked radiographically to ascertain that the criteria described above are met.

OPEN REDUCTION WITHOUT INTERNAL FIXATION

Occasionally transverse or short oblique fractures occur with sufficient overriding that closed reduction is impossible. These fractures are completely stable once reduced; therefore, an open reduction is accomplished using a bone elevator to reduce the fracture fragment, and no internal fixation is necessary. These fractures are then incorporated in plaster or some cast material and treated as closed fractures after closed reduction. Fractures treated in this manner include midshaft to distal one third radial and ulnar fractures and proximal transverse tibial fractures. By obtaining a perfect reduction, these fractures usually heal rapidly without further interference of the blood supply by an internal fixation device. When performing open reduction without internal fixation, it is important that internal fixation equipment be available should it become necessary at the time of surgery.

Reduction of the fracture itself is accomplished by using an elevator inserted into the medullary cavity of the proximal fragment and then levering the distal fragment into place while removing the elevator. It is important to interdigitate the fracture surfaces perfectly so that they are stable. The surrounding musculature then exerts further axial force against the fracture surfaces to provide stability. The reduction must be adequately maintained while applying the cast or splint.

The position used for this procedure maintains firm gentle traction on the extremity during the entire procedure to allow adequate immobility to apply a cast following reduction. ([See Chapter 15.](#))

The surgical exposure necessary for such fracture reduction is usually minimal and the time interval to accomplish this is often shorter than that of the manipulation required to perform closed reduction of closed fractures; therefore, the risks of infection are extremely low.

EXTERNAL SKELETAL FIXATION

Transfixation pinning, whether using half pins or full pins, can be accomplished by means of either open or closed reduction techniques. Occasionally in severely comminuted fractures, the proximal and distal fragments are grasped with the transfixation pins to maintain axial alignment, allowing the central comminuted aspect of the fracture to coalesce and heal. In these cases open reduction is usually not carried out, but the end result is satisfactory. Transfixation pinning is also often used with open reduction of open fractures following thorough surgical debridement.

Contraindications for external pin fixation include fractures in which an adequate purchase of the fracture fragment cannot be obtained with the use of the transfixation pin. It is best not to use transfixation pins through areas where a large muscle mass must be penetrated to attach the pin to the bone, since this causes soft tissue necrosis and may lead to more serious pin tract infection.

Complications include pin tract infection, loosening of the fixation, breakage of the clamps where transfixation pins are connected to sidebars, and bending of pins or sidebars causing deviation of the axis of the bone in question. ([See Chapter 16.](#))

OPEN REDUCTION AND INTERNAL FIXATION

Open reduction and internal fixation allows the anatomical reduction of fracture fragments with complete control over their immobilization. This excellent reduction and stability encourages rapid union with earlier useful function of the limb. The need for an external splint or cast, which would compromise the function of the joint and lead to muscle atrophy, is eliminated.

Indications for open reduction and internal fixation include fractures that require open reduction because of inability to reduce and/or stabilize the fracture by closed means. Many comminuted or overriding fractures cannot be brought into adequate approximation and alignment by closed methods; therefore these fractures must be treated by open reduction and internal fixation. Most of these fractures are inherently unstable when reduced; hence the internal fixation must be applied after the open reduction. Certain fractures can be treated with closed reduction and internal fixation, but the best functional result is usually achieved with open reduction and internal fixation. The criteria for using one method over another depend on the expected result, the final desired function of the animal, and the skill of the surgeon. Occasionally open reduction and internal fixation is performed with the goal of limiting the convalescent period of rehabilitation. The total time of the surgeon involved with the patient decreases, since it is unnecessary to perform cast or splint changes weekly over a continuing period. This results in faster rehabilitation of the dog and fewer problems for the owner. Fractures associated with arterial laceration and/or nerve trunk denervation are often opened as a result of these complications. Since it is important to immobilize the fracture to prevent reinjury of the trapped nerve or injured blood vessel, internal fixation is accomplished at this time.

In open fractures it is often necessary to debride the bone surgically. Since these fractures are already open, it may be advantageous to provide internal fixation to immobilize the bone, which in turn assists in immobilizing the soft tissues, thus speeding consolidation of the wound as well as the fracture. Certain open fractures should not be treated with internal fixation. ([See Chapter 36.](#))

Problems associated with open reduction over and above those associated with closed reduction relate to the risks of infection. Therefore open reduction should not be considered if the soft tissues are incapable of healing. This is not uncommon in badly comminuted fractures in which the vascularity of the soft tissues may be compromised as a result of the explosive nature of the fracture injury itself. Additional contraindications to open reduction with internal fixation are associated with lack of adequate equipment to accomplish the proposed procedure and inadequate training or skill of the surgeon. The equipment available for performing certain internal fixation procedures is not a luxury but a necessity. When contemplating open reduction and internal fixation, the surgeon should have available every instrument necessary to accomplish the proposed task. It is important to have several back-up measures in readiness, supported by adequate equipment, should the proposed procedure fail. Although there are times when procedures will not proceed as planned, the excuse of inadequate equipment associated with failure of internal fixation only reflects the lack of preparedness of the surgeon.

Open reduction and internal fixation should be carried out as soon as the patient is able to withstand the rigors of anesthesia. It is important that the animal be stable and can be assumed to survive the procedure before attempting open reduction and internal fixation. If the open reduction and internal fixation can be accomplished before a great deal of swelling has occurred, the reduction of the fragments is much easier and the time of surgery reduced. Since the time of surgery is often related to the susceptibility of the patient to infection, this is a significant point to consider. The literature reports that delayed open reduction and internal fixation is associated with a decreased rate of nonunion.⁽³⁾ This delay of approximately 10 days probably allows the soft tissues to revascularize, resulting in healthier tissue at the time of surgical interference. The problem associated with this delay is that the reduction itself can be difficult to accomplish. The slight advantage of decreased rates of nonunion associated with experimental animals therefore becomes of secondary importance when treating clinical patients. It is important, however, not to perform open reduction and internal fixation at the height of the edema phase, since closure of the wound may be jeopardized by suture line tension, resulting in tissue necrosis and wound breakdown with impending infection of both soft tissue and bone.

LUXATIONS

PRINCIPLES OF REDUCTION

Rehabilitation of the whole patient is the object of the treatment of fractures, dislocations, and fracture dislocations. When dealing with dislocation (a complete disruption of the joint so that the articular surfaces no longer contact each other), the clinical signs shown by the animal may mimic those of fracture. Physical examination may at times be confusing when trying to separate dislocation from fractures. The clinical features of pain, deformity, loss of motion, and crepitation are often similar. Certain characteristic stance positions of the animal with a dislocated elbow or hip may help in the diagnosis, while the rigidity with which some limbs are held may make the diagnosis of dislocations more probable than that of fracture.

It is important to use radiographs in the diagnosis and evaluation of dislocations. The possibility of complete superimposition of the two components of a joint so that the joint appears to be intact makes two-plane radiography a necessity. Radiographs will delineate the possibility of a fracture associated with the dislocation (fracture-dislocation). The avulsion of bone from the acetabulum is common in dislocations of the hip. This bony fragment attached to the round ligament is frequently a reason for the failure of closed reduction. Often chip fractures can be associated with dislocation of the elbow joint, making open reduction and removal of the chip advantageous. Whenever dislocations occur in the presence of chip fractures of substantial size open reduction is often indicated. Internal fixation or excision of the fractures, depending

on their size, can be accomplished at the time of open reduction.

Neural involvement can occur with dislocations, especially those that leave the joint completely unstable. Anatomically most nerves pass very close to the joints as they radiate to the distal extremities. It is, therefore, important to do a thorough neurologic examination at the time of injury and periodically after reduction whether it be open or closed.

The treatment of dislocations involves reduction of the joint, immobilization while attempting to gain stability, then remobilization of the joint to gain function. Reduction of a joint should be done under general anesthesia. Most joints are difficult or impossible to reduce under heavy sedation and would require unnecessary suffering by the patient. Dislocations, like fractures, are easier to reduce when fresh.

Therefore, reduction should be carried out as soon as the animal is stable enough to undergo general anesthesia. The majority of joint dislocations that are seen in small animal orthopaedics can be reduced in a closed manner. It is important to have a thorough knowledge of the anatomy of the joints involved as well as the mechanism for luxation. Most luxations are successfully reduced by reversing the cycle of dislocation. As in the hip, where cranial dorsal luxation occurs by external rotation and adduction of the hip while in extension, it would follow that the hip can be reduced by the same manipulation but in reverse. Once the joint is reduced it must be immobilized so that stability is regained. There are certain exceptions to this rule, such as a ventral dislocation of the hip in which stability is achieved at the time of reduction. In this case mobilization of the joint is carried out while at the same time preventing abduction of the limb, which would allow recurrence of the dislocation. The type of immobilization required for each dislocation may vary even with involvement of the same joint. For example, the shoulder when reduced is sometimes stable in flexion with a Velpeau sling, while other shoulder dislocations may require extension such as can be accomplished with a Schroeder-Thomas splint. It is important to take the affected joint through a range of motion to determine what position will yield the greatest degree of stability. Some joints always require the same position for immobilization to be successful. Dislocation of the elbow is almost always most stable in extension with the anconeal process locking into the supertrochlear foramen.

The time interval for immobilization of the joint depends on the severity of the soft tissue injury. In general relatively short periods of immobilization (10 days to 2 weeks) are advocated in order not to permanently impair joint function and range of motion. Further support, allowing more motion of the joint, may then proceed.

The mobilization of joints following immobility is usually left to the ingenuity of the patient and its owner. Attention paid to this portion of the treatment will often make a significant difference in the end result. Rehabilitation of the patient through physical medicine techniques has only recently been gaining foothold in veterinary orthopaedics(2) As the specialty matures and case material is followed for results there will be a strengthening of this phase of treatment.

COMPLICATIONS OF REDUCTION

Complications involving dislocation of joints are associated with inability to reduce the joint through closed or open techniques, the inability to maintain reduction of the joint once reduced, and the loss of function of the joint following successful or unsuccessful regimes. Failure to provide reduction through closed means may be related to the innerposition of soft tissues in the joint, fracture fragments in the joint, or severe muscle spasm. A great amount of time should not be expended in manipulation through closed reduction if positive results are not forthcoming. Additional damage can be done to the joint surfaces through this manipulation, and open reduction should be done immediately if closed reduction is not satisfactory. In rare instances open reduction may be very difficult to accomplish and may require such additional help as can be provided through osteotomy. (See Chapter 40). Reoccurrence of dislocation during immobilization or in the early phase of remobilization can be disheartening. A careful evaluation of the joint involved or exercise pattern may provide reasons for this recurrence of dislocation. Animals with hip dysplasia frequently have reoccurrence of dislocation of the hip following mobilization. In some instances this then may lead to further treatment methods such as excision arthroplasty. Dysfunction of the limb following treatment may be based on problems with the joint and/or muscle and/or nerve function. Reasons for the failure must be determined before an adequate treatment regime can be suggested. The techniques for dealing with each particular dislocation will be discussed under the heading of that joint.

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