

Management of Open Fractures and Joint Injuries

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DEFINITIONS AND CLASSIFICATION

Open fractures are also called *compound fractures*, whereas closed fractures are sometimes referred to as *simple fractures*. Open fractures and joint injuries are those in which bone or joint structures have been exposed to the environment. The degree of soft tissue injury and contamination is used to categorize these open injuries as Type I, II, or III (discussed in more detail below). Use of this classification scheme provides the veterinarian with a general basis for case management.

One should realize that the various types of open injuries represent a continuum and that many open injuries affecting bones and joints seem to fall somewhere between types. In addition, the degree of soft tissue injury does not always correlate with the degree of contamination. A penetrating joint injury may be associated with very little soft tissue injury yet have a high risk of contamination and infection (e.g., such as is seen with barnyard injuries). In these circumstances it is best to classify the open injury as a higher category of severity.

Type I Injuries

Type I injuries have the least amount of soft tissue trauma and contamination. They include those injuries in which soft tissue disruption was caused by the bone fragments themselves (i.e., wounding from the inside outward). There is rarely any significant soft tissue loss with Type I injuries, and one usually cannot see bone or joint structures by visual inspection of the wound. Many of the associated fractures are noncomminuted.

Type II Injuries

Type II injuries are characterized by soft tissue dis-

ruption and contamination that are intermediate to Type I and III injuries. Most Type II injuries have soft tissue defects that allow one to see the injured bone or joint. The wound has usually been created by an external force such as a laceration or abrasion (shearing wound). Most fractures in Type II injuries are either noncomminuted or only minimally comminuted.

Type III Injuries

Type III injuries are those with the most severe soft tissue damage and contamination. Type III injuries are often the result of external forces such as penetrating wounds (gunshot), abrasive forces (shearing wounds), or crushing injuries. There is often substantial soft tissue loss. The extent of soft tissue injury may not be evident initially, especially if the injury was caused by a crushing force. Open fractures or joint injuries that are sustained in barnyards should be considered Type III even when the degree of soft tissue injury would not warrant this grade. Most Type III open fractures are comminuted, and fragments of bone are often missing or are too small to allow for primary fixation.

PRINCIPLES OF TREATMENT

The following principles (in the order listed) have been described by Gustilo¹ as being essential to the successful treatment of open fractures in humans:

1. Open injuries to bones and joints should be treated as emergencies.
2. The patient should be evaluated carefully to diagnose other life-threatening injuries.
3. Appropriate and adequate systemic antibiotic therapy should begin immediately.
4. The wound should be thoroughly debrided and cleansed.
5. The fracture or joint injury should be stabilized; cancellous bone grafting can be performed immediately or can be delayed.
6. The wound should be appropriately dressed or closed; measures should be taken to facilitate wound drainage.
7. The limb and patient should undergo rehabilitation.

The above principles apply equally well to dogs and cats. The first few hours of treatment will often dictate the outcome in animals that have sustained an open fracture or joint injury. Careful evaluation is necessary

to determine the type and extent of other injuries that might be present.

Systemic antibiotic therapy should begin immediately in all patients that have sustained an open bone or joint injury. Most authorities advocate taking a culture at the time antibiotic therapy is begun. Cephalosporins are generally a good initial antibiotic choice because of their bactericidal mechanism of action, broad antibacterial spectrum, availability in parenteral and oral forms, and relative lack of toxicity. Antibiotic therapy should continue through surgery and possibly for 2 to 3 days thereafter. Longer use of antibiotics may be necessary if the wound was severely contaminated or if soft tissues were severely devitalized. Antibiotic selection should be reevaluated after the culture results are known or when local or systemic signs of infection develop.

Adequate debridement using surgical dissection and copious lavage is the most important step in treating open fractures and joint injuries.¹ Although it may be tempting to delay wound management until the animal is "stable," delays can have serious adverse consequences. Initial debridement and cleansing can often be undertaken during efforts to resuscitate the animal or can be performed while other treatments are being rendered. Adequate early treatment for shock, pneumothorax, or other problems lowers the risk associated with general anesthesia and allows its use at an earlier time. Additional debridement may be necessary if there is further death of tissue or accumulation of exudate or debris. If there is any doubt about the adequacy of the cleansing effort, it is advisable to leave the debrided wound at least partially open or to use other methods of maintaining drainage. The importance of proper wound management is highlighted by the following quote attributed to Louis Pasteur. "*The germ is nothing. It is the terrain or environment in which it grows which is everything.*"¹ Antibiotic therapy should never be used in lieu of proper wound management.

The method used to stabilize the fracture or joint injury is highly dependent on the type and location of the injury, the degree of soft tissue injury and contamination (i.e., whether it is a Type I, II, or III injury), and the veterinarian. In general, there is progressively less latitude in choosing a method of stabilization as the severity of the open injury increases (discussed below).

When the wound has been left open to heal by second intention, it is imperative that steps be taken to allow contraction to occur. A wound that has healed mostly by the process of contraction is cosmetically and structurally more desirable than one that has healed by epithelialization. The veterinarian can influ-

ence wound healing by altering the factors that adversely affect the process of contraction (i.e., health of the granulation bed [infection], tension in the wound margins, and contact inhibition). Infection, which can be identified by visual inspection of the granulation bed, is often present when the granulation tissue is slow to form, exuberant, irregular, discolored (purple), and productive (exudative). Infection may also be present when wound contraction seems to be progressing slowly. Thorough debridement and more frequent bandage changes will often help resolve the infection. Adherent nonocclusive dressings (wet or dry) are used until the granulation bed is well developed. Nonadherent nonocclusive dressings are used thereafter. Undue tension on the wound margin may be relieved by removing percutaneous pins, making tension-relieving incisions, or immobilizing joints via external coaptation.

SPECIFIC RECOMMENDATIONS

Type I Injuries

As long as certain precautions are taken, treatment of Type I injuries can proceed as though the bone or joint was never exposed. Upon entry for stabilization of the bone or joint injury, the wounded soft tissues should be inspected and devitalized tissue and debris should be removed. Various methods of fixation can be considered; however, external coaptation in a cast is usually not used as it precludes evaluation of the wound. Primary closure of the wound can usually be performed as long as one is confident that contaminants have been excised. Systemic antibiotic therapy is indicated.

Type II Injuries

Proper wound management is especially important with Type II open fractures or joint injuries. The soft tissue wound should be thoroughly debrided and cleansed; drainage should be maintained by leaving the wound at least partially open or by using drainage tubes (Penrose, sump, etc.). Treatment of the fracture or joint injury is usually performed at the time the wound is initially managed. External coaptation via a cast is not recommended (see Type I injuries). Rigid fixation is important because of the increased chance of infection and delayed healing due to contamination and soft tissue injury. The importance of adequate stabilization is emphasized by Sir Reginald Watson-Jones, who said: "*The fact is, infection is not a cause of nonunion. If nonunion is allowed to occur, it is due not to infection, but to inadequate immobilization permitted by reason of infection.*"¹ Systemic antibiotic therapy is indicated in all Type II injuries.

Type III Injuries

Soft tissues are the focus of attention with Type III injuries. Classically in humans, primary fixation of Type III open fractures is delayed until the soft tissues begin to heal (i.e., until a granulation bed has formed). The soft tissue wound should be thoroughly debrided using surgical methods and lavage. Following debridement the soft tissues are generally left open to allow for drainage and further debridement via surgery or dressing removal. Occasionally, it is possible to perform a partial or complete primary closure over a surgically implanted drainage system (Penrose tubing, sump drains). Nonocclusive adherent dressings (wet or dry) are applied to the wound and are held in place by a bandage. The bandage can have a coapting effect if it is bulky (Robert-Jones bandage) or when a splint has been incorporated within its structure. Once a healthy bed of granulation has developed, nonocclusive nonadherent dressings are used and treatment of the fracture or joint injury commences. Systemic antibiotic therapy is advocated before, during, and after surgery for Type III injuries.

Unfortunately, there are practical problems associated with delaying fracture repair in Type III injuries in dogs and cats. Inadequate immobilization of bone fragments or the presence of an unstable joint may al-

low further soft tissue injury, prevent early return to function, and preclude bandage changes in the unanesthetized animal. Decubital skin ulcers, limb edema, and pneumonia may develop if the animal has other injuries that preclude ambulation. As such, delayed treatment of fractures and joint damage is typically not practical and usually increases morbidity and convalescence time.

Early primary fixation in animals with Type III injuries is generally accomplished with an external fixator or with bone plates. Plates are used in "buttress fashion" whenever reconstruction of the bone is impossible or when reconstruction might cause additional significant soft tissue damage. In this regard, use of an external fixator has an advantage over plate fixation in that it allows one to avoid further soft tissue trauma at the site of injury. A disadvantage of external fixators is that they require more careful postoperative management to avoid loss of fixation (pin tract infection). In addition, percutaneous fixation may interfere with wound closure (contraction).

REFERENCE

1. Gustilo RB: Management of open fractures and their complications, vol IV. *Saunders Monographs in Clinical Orthopaedics*. Philadelphia, WB Saunders, 1982, pp 15-54, 133, 159.

