# Managing Open Fractures

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An open fracture is one in which there is communication between the fractured bone fragments and the external environment. As such, there are special considerations for open fractures and the management of the associated soft tissue wounds. This session will address the classification, evaluation and treatment of open fractures taking into consideration the effects of concurrent soft tissue damage. Emphasis will be on the techniques and principles for addressing a wide variety of cases.

**Open fracture classification scheme**

**Type 1**

External wound is often created from the inside out by sharp bone fragments. Wound is small; generally less than 1cm and soft tissue contusions are mild to moderate resulting from low to moderate energy impact. It is not uncommon for the bone to have retracted into the soft tissues, emphasizing the importance of careful evaluation of the skin with any fracture case.

**Type 2**

Variably sized soft tissue wound, but generally greater than 1cm. Tissue damage is not extensive, though is generally created from the outside in and associated with higher energy forces.

**Type 3**

Soft tissue injury is extensive and there is a varying degree of compromise to vascular and neural supply. There is severe bony fragmentation indicative of high-energy injury. Type 3 open fractures have been subcategorized into Types 3a, 3b and 3c based on the degree of soft tissue injury. Basically, Type 3a fractures have enough skin remaining to allow for coverage. Type 3c fractures are associated with severe loss of tissue and compromised arterial supply and carry a very guarded prognosis.

**Initial patient management**

Initial management of patients with open fractures involves thorough assessment of the patient with management of any systemic compromise to ensure a cardiovascularly stable patient. Once stabilized, or during the stabilization if possible, an open fracture should be protected from further contamination and damage. Careful management of the patient is important so that closed fractures don't turn into open fractures and type x fractures don't progress into type x+1 fractures

Contaminated wounds in open fractures are 5 times more likely to develop postoperative complications and this increase risk is seen regardless of bacterial culture results if the patient is febrile. Most infections that develop are mixed gram+ rods and cocci and gram- organisms. Therapy with broad spectrum antibiotics should be initiated following collection of a sample for aerobic and anaerobic culture. Gram stain can be useful to guide antibiotic choice. Antibiotic therapy is modified once bacterial culture results are available.

**Soft tissue wound management considerations**

As with management of any open wound, the objective is to convert a contaminated or dirty wound into a clean wound and close, re-establishing the protective barrier. Removal of dead and damaged tissues prevents bacterial overgrowth and decreases risk of infection. In general, muscle and fat debridement can be fairly generous, while judicious debridement of skin (especially on distal limbs or with specialized structures such as paw pads), tendons, ligaments, and neurovascular structures is employed. Development of additional compromised or damaged tissue can be limited by avoiding mass ligation and utilizing sharp debridement preferentially. Vascularized bone fragments are left in place and care is taken not to disturb the blood supply to those fragments.

Copious lavage is performed with a warm, sterile, isotonic solution under mild to moderate pressure. High pressure lavage can damage tissues and drive contaminants deeper into the wound. Hypertonic solutions (plain water) should be avoided when possible. Variable results have been obtained with using additives for lavage solution. Scrub and high concentrations of additives can be toxic to cells.

**Fracture stabilization considerations**

In general, a type 1 open fracture can be cleaned and treated as if closed; however, diligent evaluation for deep contamination is important. For open fractures of type 2 or 3, emphasis is on rigid stabilization. While healthy tissues can contribute to callus formation in the face of a tenuous fracture repair, infection and inflammation can compromise the bone healing process and small amounts of movement at the fracture cannot be overcome. If an open wound is expected to remain following fracture stabilization, the repair is planned so as to maintain a favorable environment for open wound healing and management. Open fracture fixation is a classic

indication for use of circular, linear, or hybrid external fixation. Internal fixation with various types of bone plates or with interlocking nails has been used successfully with type 2 or 3 open fractures. Pins and wires, external splints, or poorly planned bone plates and external fixation constructs are avoided.

Joint involvement poses an additional challenge. Contamination in joints can be harder to control and may affect healing more significantly. Rigid stabilization of small fragments near joints can be challenging and requires careful presurgical planning. Risk for development of osteoarthritis is increased with any fracture involving a joint and the possibility of infection may increase that risk.

Cancellous bone grafting can be a helpful adjunctive treatment for open fractures. Cortical grafts have a poor rate of "take" and are avoided. When harvesting bone graft, new instruments and gloves are used to ensure no contamination is introduced into the graft site. When open wounds are present, graft must be able to be placed where it is protected from immediate drainage from the implantation. With severe open wounds, delayed grafting may be indicated.

**Ancillary procedures**

Healing of open fractures is enhanced with placement of soft tissue grafts. Grafts used include muscle flaps, myocutaneous or cutaneous grafts, Free vascular grafts can be used but require specialized equipment and microvascular techniques. The most important consideration is viability and vascular supply of the graft tissue.

The use of drains in the face of open fractures is controversial. Some surgeons recommend the use of open wound management with serial bandage changes over placement of any type of foreign material near the fracture. If drains are used, closed suction drains are strongly preferred over gravity drains.

Negative Pressure Wound Therapy has been introduced to veterinary surgery relatively recently and may be a great adjunct to management of severe open fractures.

**Postoperative care and prognosis**

Postoperative management of patients with open fractures will be very similar to that for closed fracture patients, with increased emphasis on activity restriction. Additionally, open wound management and implant care may be indicated. Consideration is made for reculturing open wounds if healing is not proceeding as expected.

Failure or complications of open fractures type 2 or higher are not uncommon and include wound infection, osteomyelitis or sequestrum formation, and delayed union, malunion or nonunion. In a study reviewing type 3 open fractures in humans, amputation was the ultimate result in none of the type 3a open fractures, 16-17% of the type 3b fractures and up to 78% of the type 3c fractures.

**Conclusions**

Management of open fractures in veterinary patients requires special consideration of the effect that soft tissue damage has on the subsequent repair and outcome of healing. It is important to take this information into consideration and to be prepared for their implications. Owners must be counseled on prognosis and possible need for multiple procedures. That said, with careful planning and adherence to wound management principles, most open fractures can be successfully managed.