Postoperative Management of External Fixators in Dogs and Cats

Despite the widespread use of external skeletal fixation in small-animal practice, little information is available regarding postoperative care. Here are some tips to promote optimal healing, keep patients comfortable, and avoid complications.

External skeletal fixation is frequently used for fracture stabilization, arthrodesis, and angular limb deformity correction in dogs and cats. While construct design and application can vary substantially, all external fixators (linear, circular, and hybrid) consist of an extracorporeal frame and fixation elements—either pins or small-diameter wires—that stabilize the engaged bone segments. The protruding fixation elements and external frame present unique considerations with regard to appropriate postoperative management.

A variety of recommendations have been made regarding the management of external fixators; however, clinical studies evaluating the efficacy of postoperative management methods have not been reported. Our recommendations in this article reflect the limited research available in human patients and animal models, as well as our clinical experiences.

1. The limb and fixator are cleaned using an unfolded and rolled gauze sponge in preparation for bandaging after surgery. The gauze has been moistened with chlorhexidine solution.

2. The end of the fixation pin has been cut close to the clamp’s primary fixation bolt. A protective plastic cap has been placed and glued on the end of the trimmed fixation pin.

3. The ends of the wires in this circular fixator are curled around the ring to prevent damage from sharp ends.

**FIXATOR PREPARATION**

Decreasing postoperative morbidity associated with external skeletal fixation begins during and immediately after surgery. Proper application is essential to preventing complications and includes using safe corridors that avoid placing
fixation elements through large muscle groups or neurovascular structures, predrilling pilot holes for pin placement, using threaded fixation pins, and ensuring that the construct applied provides adequate stability.

Make release incisions through the skin and continue them via blunt dissection through the underlying soft tissues when placing fixation elements. The release incisions should be a minimum of 1 cm and of sufficient length that the fixation element does not create tension in the adjacent tissues as the limb is put through a full range of motion. Thoroughly tighten all clamps, bolts, and nuts associated with the frame.

After surgery, clean the fixator and limb of any blood or debris, and dry the fixator and limb segment (Figure 1). Cut fixation pins flush with the clamps, and apply protective plastic caps to the cut ends of each pin (Figure 2). With circular or hybrid fixators, cut the ends of the wires about 2 to 3 cm from the fixation bolt, and curl the wire ends around the frame (Figure 3).

**INITIAL POSTOPERATIVE BANDAGING**

Immediately after surgery, place a compressive bandage, similar to a Robert-Jones bandage, on the operated limb. First, apply topical antibiotic (e.g. bacitracin, neomycin, and polymyxin B) ointment at the fixation element-skin interfaces to decrease microbial contamination and migration from the skin surface to the fixation element tract. Then place sterile nonadherent dressings or gauze over any incision and around each fixation element-skin interface to prevent adherence of other bandage layers. Cut slits in the dressing to facilitate placement around individual fixation elements (Figure 4).

Next, place padding, consisting of either sheet cotton or the detached foam portion of rinsed and dried surgical scrub brushes, between the stabilized limb segment and the fixation elements. If foam is used, again cut slits in the material to facilitate placement around the fixation elements (Figure 5). If sheet cotton is used, layer the cotton sufficiently to compress the underlying soft tissues when packed between the frame and the stabilized limb segment.

Then wrap the limb and fixator in cast padding or sheet cotton, beginning at the digits and extending just proximal to the fixator. Wrapping only the stabilized limb segment can cause edema and congestion in the extremity distal to the bandage. Apply a compressive layer of conforming self-adherent gauze over the cast padding, followed by a tertiary layer of cohesive bandage material (Figure 6).

This bandage absorbs exudate from the release incisions and decreases postoperative swelling that could lead to contact between fixator components and soft tissues, which has the potential to cause soft tissue necrosis. The
compression also decreases motion of the soft tissues around the fixation elements. Excessive motion can cause tissue strain, which leads to increased drainage and potential loosening of the fixation elements.\textsuperscript{2,3}

Keep a compressive bandage in place until postoperative swelling has subsided and release incisions begin to heal by second intention.\textsuperscript{1} The frequency of bandage changes is determined by the necessity to treat open wounds (if present), the volume of drainage from the fixation element tracts, the amount of soft tissue swelling, and the condition of the bandage (e.g. if the bandage becomes wet or soiled).\textsuperscript{1} The initial compressive bandage is usually removed 12 to 48 hours after surgery, before the animal is discharged, and another compressive bandage is placed. Administration of sedatives and analgesics during this initial bandage change is recommended.

SECONDARY BANDAGING

Two forms of secondary protective bandaging techniques have been described for use once a compression bandage is no longer warranted - bumper bandages and shrouds. Both are aimed at protecting the construct, animal, and owners from damage or injury due to accidental impact or entrapment of the frame on objects. The protective bandage needs to allow for exposure, monitoring, and care of the fixation element-skin interfaces.

Bumper bandages

A bumper bandage is composed of a layer of cohesive bandage material covering only the frame components and exposed ends of the fixation elements (Figure 7).\textsuperscript{7,8} The fixation element-skin interfaces remain visible for monitoring and accessible for care. Sometimes a primary layer of gauze or cast padding may be placed before the cohesive material to provide extra padding and protection. Fixators placed on proximal limb segments are often only amenable to the bumper bandage form of protective bandaging.

Shrouds

A shroud consists of a fabric sleeve with a length and diameter that loosely conforms to the stabilized limb segment and fixator, secured at each end with a drawstring or elastic band (Figure 8).\textsuperscript{5,6} We recommend that the owner have several shrouds so that a clean shroud can be placed over the fixator after daily fixation element-skin interface care. The shroud is advantageous in that it protects the fixation element-skin interfaces from environmental contaminants, while still allowing simple access for care of fixation element tracts. Shrouds can be purchased from commercial sources (DogLeggs.com) or can be self-fabricated. For example, the elastic portion of a tube sock is a simple and economical substitute that can be used for smaller constructs.
FIXATION ELEMENT-SKIN INTERFACE CARE

There is a lack of consensus and research regarding the appropriate management of the fixation element-skin interfaces in dogs and cats. Multiple cleansing agents have been advocated, though each has inherent benefits and faults.

Chlorhexidine

Dilute chlorhexidine solutions are advocated by many surgeons. In a clinical study in people, a 0.2% chlorhexidine solution decreased fixation element tract infection compared with sterile 0.9% saline solution. Canine-specific studies evaluating the effects of varying concentrations of chlorhexidine diacetate on in vitro tissue samples found concentrations of chlorhexidine greater than 0.013% to be cytotoxic to fibroblasts, though increased Staphylococcus aureus survival was noted when chlorhexidine concentrations were below 0.05%.

A clinical study of the effects of various cleansing agents on canine wound infection rates and healing found that 0.05% chlorhexidine solution showed greater antimicrobial effects than sterile saline solution or povidone-iodine solution, and healing of wounds treated with 0.05% chlorhexidine solution was determined to be comparable to wounds cleansed with iodine solutions and superior to wounds cleansed with sterile saline solution alone. Chlorhexidine will precipitate when diluted with saline solution; however, precipitation does not inhibit the solution’s antimicrobial effect. Precipitation can be prevented by diluting the chlorhexidine solution with sterile water instead of saline solution.

Povidone-iodine

Some surgeons recommend povidone-iodine solutions as cleaning agents. Dilute iodine solutions have been found to have no benefit over sterile saline solution as a cleansing agent for fixation element-skin interfaces in people. Cytotoxicity to canine fibroblasts has been documented when povidone-iodine concentrations exceed 0.5%, but concentrations greater than 1% are necessary for antimicrobial effects against S. aureus. Iodophors also have diminished antimicrobial function when in contact with exudate and can cause corrosion of stainless steel fixation pins.

Hydrogen peroxide

Hydrogen peroxide has been recommended by some surgeons and is economical and readily available to most owners. However, diluted hydrogen peroxide has been shown to exhibit cytotoxic effects on osteoblasts and fibroblasts even at concentration dilutions that do not provide significant antimicrobial action.

Hydrotherapy

Hydrotherapy has also been recommended to help maintain cleanliness of the fixation element-skin interfaces, as well as to decrease postoperative swelling. Hydrotherapy consists of subjecting the limb and frame to clean
running water for periods of roughly 10 minutes with or without application of an over-the-counter antimicrobial shampoo to the limb and apparatus once or twice weekly. Studies performed in people report statistically equivocal infection rates whether or not fixation element-skin interface cleaning was performed when patients were allowed to shower daily. Hydrotherapy attempts to recreate a similar level of hygiene in pets.

Our recommendation

We recommend that the owners clean the fixation element-skin interfaces daily with a 0.05% chlorhexidine solution followed by application of a triple antibiotic (e.g. bacitracin, neomycin, and polymixin B) ointment to these sites. After the release incisions have healed, we also recommend once or twice weekly hydrotherapy.

PREVENTION AND TREATMENT OF COMPlications

Complications can develop after applying external fixators, including element tract drainage, element loosening, infection, and pin tract fractures. Take preventive measures to avoid these complications, including client instruction on postoperative restrictions and care.

Element tract drainage

The most common complication associated with the use of external fixation is fixation element tract drainage. Mild to moderate drainage from the fixation element tracts, typically serosanguineous in nature and without irritation of surrounding tissues or implant loosening, is to be expected in the initial postoperative period. Drainage is more likely to occur if the fixator is in a proximal location on the limb, where muscle is more prominent. Soft tissue motion around a fixation element prolongs the débridement phase of wound healing and incites exudation. Excessive or prolonged drainage increases the likelihood of fixation element loosening and infection. Prevention includes the appropriate placement of fixation elements through adequate soft tissue release incisions and the application of a compressive bandage in the early postoperative period.

Element loosening

Loosening of fixation elements is another commonly reported complication of external fixation. The bone-fixation element interface is the weakest link of the construct. Bone resorption and subsequent implant loosening can occur if thermal necrosis of the bone surrounding the fixation element tract occurs during placement, the bone-fixation element interface is subjected to high stress loads from placement of pins or wires too close to the fracture site, insufficient frame
stiffness is present, excessive soft tissue movement around the fixation elements occurs, or a fixation element tract infection develops.\textsuperscript{1,2,5}

Loose pins or wires are a continual source of pain and can predispose the animal to fracture disease, osteomyelitis, delayed union, or nonunion.\textsuperscript{2} Thus, loose fixation elements should always be removed.\textsuperscript{2} Removal may compromise the stability of the construct and necessitate placement of additional fixation elements if osseous union has not progressed sufficiently to accommodate for the decrease in frame strength.\textsuperscript{3,5}

4. A sterile nonadherent dressing is placed directly on the skin. Slits have been cut into the dressing to facilitate placement of the dressing adjacent to the fixation pins, thus protecting the fixation element-skin interfaces.

5. Foam sponges are packed between the limb and fixator. Slits have been cut in the foam sponges, similar to those made in the nonadherent dressings, allowing for easier placement.

6. A compression bandage has been applied over the tibial fixator. The remainder of the limb distal to the fixator has also been bandaged to prevent swelling of the hock and paw.

7. A secondary bumper bandage has been placed over the humeral hybrid fixator in a cat. The fixation element-skin interfaces are visible and accessible for cleaning.

8. A secondary shroud has been placed over the fixator on a dog. The fixation element-skin interfaces are protected from environmental contamination, yet the covering can be removed for daily treatment of the interfaces.
Infection

Infection of a fixation element tract should be considered any time fixation element tract drainage appears purulent, fixation elements associated with excessive drainage are loose, radiographic evidence of bone lysis around the fixation element tract is present, or patient use of the limb declines.\textsuperscript{2,3} Treatment of fixation element tract infection includes removing the fixation element, débriding the fixation element tract and surrounding soft tissues, and administering systemic antibiotics.\textsuperscript{2} If the removal of the affected fixation element compromises the stability of the construct, an additional fixation element should be placed in the same bone segment at a different site.

Although the most commonly reported causative pathogens are Staphylococcus species, treatment based on bacterial culture and antimicrobial sensitivity testing is recommended.\textsuperscript{1-3} Culture of the external fixation element-skin interface can be misleading because of contamination by normal skin flora, so it has been advocated to obtain a culture sample from inside the fixation element tract, such as a swab of the lining of a fixation element tract, débrided bone, or the previously implanted portion of the offending fixation element after removal.\textsuperscript{2,5}

Pin tract fractures

Fracture through pin tracts is also a rarely reported complication of external fixator placement and is typically a sequela of improper surgical technique. Use of fixation elements that exceed one-third the diameter of the bone; placement of a fixation pin in proximity to other fixation pins, the fracture, or the osteotomy; and inadequate postoperative exercise restriction have been implicated as causes of fractures.\textsuperscript{5} Any fixation element associated with an iatrogenic fracture should be removed and replaced in intact bone.\textsuperscript{5}

Client education

Inform owners of the importance of strict activity restriction to allow for bone healing. Until there is radiographic confirmation of bone union, the animal should be confined to an area small enough to prevent running, jumping on and off furniture, or rough play with other pets. Animals should always be restrained on a leash when taken outside.

While a crate is often an ideal enclosure for animals after orthopedic procedures, open wire crates and kennels with wire mesh pose a potential risk for entrapment of protruding pieces of the fixator and damage to the construct. The same consideration applies any time that an animal is hospitalized in a clinic kennel.

RECHECK EXAMINATIONS

The time between routine recheck examinations should be based on the patient’s clinical progress, the development of complications, and the owner’s compliance level of caring for the animal and fixator at home.\textsuperscript{1,6} At each recheck examination,
inspect the apparatus and tighten any loose components. If at any point the owner thinks that any portion of the construct is loose or a complication is developing, perform an evaluation as soon as possible. Obtain radiographs at four- to six-week intervals, as warranted by the procedure performed and radiographic assessment of healing.

Staged destabilization of the construct is the practice of removing portions of the frame to decrease fixator stiffness and potentially increase the rate of healing by increasing the load placed on the bone. Destabilization is typically begun about six weeks after surgery. Staged destabilization is not uniformly accepted, and studies investigating its efficacy have yielded variable results. We typically only remove fixator components that are causing morbidity.

The fixator can be removed when clinical and radiographic evidence of bone healing are noted. Most fixation elements can be removed by hand using a Jacobs chuck. Sedation or a brief period of anesthesia with concurrent analgesic administration is recommended, as removal of fixation elements can cause painful stimulation of the periosteum. Obtain radiographs after fixator removal to ensure that superimposition of the radiopaque portions of the frame over the bone did not conceal any areas of nonunion or complications. Leave the pin and wire tracts to heal by second intention, and place the entire limb in a soft padded bandage for 48 to 72 hours.

CONCLUSION

External skeletal fixation is a highly versatile and effective treatment modality, but it requires diligent care during the convalescent period. Consider the likelihood that clients and their pets will comply with postoperative care instructions before deciding to use an external fixator. Fixators often need to be maintained for a prolonged period, and if owner compliance or the pet’s tolerance of the construct is poor, the outcome will likely be less than optimal.

References


