BASIC ORTHOPEDICS FOR THE SMALL MAMMAL PATIENT

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Orthopedic trauma in rabbits, rodents, and ferrets occurs from household accidents, injury from a falling object, a closing door, attacks from another animal, an owner stepping on an animal, or by poor cage design. After initial evaluation of other body systems, an orthopedic and neurologic examination is performed. Orthopedic trauma is rarely an emergency unless a spinal fracture is suspected. Examples of the type of orthopedic injury, all small mammal trauma patients should be evaluated on an emergency basis to evaluate other body systems and administer appropriate supportive therapy and analgesics. Once the patient is metabolically and cardiovascularly stable all wounds and open fractures are addressed. Under sedation, wounds are clipped and cleaned and fractures or joint instability of the distal limbs (below the elbow and stifle) are bandaged and splinted until definitive surgery can be performed. For fractures proximal to the elbow and stifle only a spica splint is applied to the leg. It is important to note that rabbits with open fractures tend to do worse than other veterinary species because of the early development of osteomyelitis, which is difficult to treat in this species.

Preoperative planning can be difficult in small mammals because they are not easy to keep exercise restricted. They also tend to chew at bandages, splints, and wounds. Most important is keeping the patient comfortable with analgesics and preventing possible secondary complications of anesthesia and surgery in these species.

An issue related to rabbit orthopedic repair is their relatively hard and brittle long bones compared to those of dogs and cats. The bones of rabbits comprise only 8% of the total bodyweight, compared with 13% in cats. Although rabbit bone does heal well when appropriate orthopedic principles are applied, the application of large implants overprotect the bone, leading to rapid bone resorption (mimicking disuse osteopenia and osteoporosis) and secondary failure of the repair. Over protection of a long bone with too strong of a repair will lead to this complication in any species, this is not specific to rabbits. Successful fracture repair in rabbits is possible when appropriately sized implants are chosen. Open fractures are cultured and antibiotics is started. Routine post-operative analgesia and supportive care are instituted as described for other surgical procedures.

FRACTURE REPAIR TECHNIQUES
The techniques described below are a basic outline to fracture repair in small mammal patients. For the very small veterinary patient (hedgehog, mice, hamsters) or juvenile small mammal, creativity in fracture stabilization and repair is needed.

External Coaptation
Soft bandages, splints, and casts are useful in small mammals with closed simple fractures of the distal limb. Techniques and principles for external coaptation in these species is the same as in dogs and cats. Remember that the acute angles of the joints of rabbits make external coaptation challenging. It is important to keep bandaged limbs in a relatively functional position for the patient. Owners must be properly educated on the care and management of bandages and splints. Weekly rechecks are mandatory to prevent severe and life-threatening bandage complications.

Intramedullary (IM) Pinning
Intramedullary pinning techniques used in small animals can be applied to small mammals. The pin diameter should occupy 60% to 70% of the medullary cavity of the bone being pinned. In general, if Steinmann pins are too large for the diameter of their long bones Kirschner wires are used. IM pins in these species are used to overcome bending forces and achieve alignment and maintain length. When possible pins are placed in normograde fashion to avoid entering and damaging the articular surfaces of joints. The use of Kirschner wires in a cross pin fashion are best in supracondylar fractures of the humerus and femur in these species and provide excellent alignment and are strong enough to overcome most fracture forces during bone healing. Cross pinning techniques are also useful for arthrodesis of the tarsal and carpal joints in small mammals.

Bone Plate and Screws
Although bone plates can be used in small mammal fracture repair there are limiting clinical factors that may make other means of fixation more appropriate. As an example, rabbit cortices are much thinner than dogs and cats, which makes screw placement difficult leading to stripping of the screw and collapse of the bone column under the screw. Most rabbit fractures have some degree of comminution and disruption of blood supply to the bone. Plating tends to overprotect the fracture, preventing load sharing and causing delayed healing or nonunion. Although this happens in all species, rabbits tend to be clinically more affected if appropriate implant sizes are not used. In complicated fractures where IM pinning or external coaptation may not be appropriate, bone plating may be a better option than external skeletal fixation. The standard size ASIF plates are usually too large and stiff for most small mammal fracture repair. Veterinary cuttable plates that accept 1.5-mm and 2.0-mm screws can be used successfully to repair some rabbit long bone fractures.

External Skeletal Fixation (ESF)
External skeletal fixation is the most common surgical method used for repairing fractures in small mammal. ESF provides the surgeon with many options for rigidity, pin placement, and dynamization, while minimizing soft tissue damage and extraosseal blood supply. The principles for application of ESF in small mammal are similar to those of other species. The pins are inserted with low rotational speed (150 rpm) and not with manual insertion, which results in wobble and leads to premature
loosening of the pins. Small diameter threaded pins and non-threaded pins can be used. Pins are angled at 70 degrees to the longitudinal axis of the bone so that pin pullout is prevented. The benefit of ESF is that a closed or limited open reduction is performed limiting the soft tissue trauma and further damage to the blood supply. Most small mammals are too small for external bars and clamps; instead, bone cement and other acrylics can be used as connecting bars.

**Surgical Technique**

Three to four pins are placed in each bone segment with the pins at least 1 cm, or one bone diameter, from the fracture line and each pin not to exceed 20% of the bone diameter. Each pin is placed through a separate skin incision. Type I, type I tie-in, and type II ESF are the most frequently used configurations in small mammals.

- **Type I fixators** are unilateral and uniplanar. The transosseous pins engage the transcortex but do not exit the soft tissues.
- **Type I tie-in configuration** utilizes an IM pin that is bent at the proximal or distal end of the bone as it exists the skin, and is incorporated or “tied-in” to the side bar used for connecting the transosseous pins.
- **Type II configurations** are bilateral and uniplanar. The transosseous pins engage both cortices and penetrate the soft tissues medial and lateral. This is a very stable and strong design.

The connecting bar is made from bone cement or other acrylic and is 1 cm away from the skin to accommodate postoperative swelling. The fixator is evaluated every week, the pin tracts cleaned with a dilute chlorhexadine solution, and the bars rewrapped with clean material. Radiographs are assessed at 4 weeks to assess fracture healing and every 3 to 4 weeks thereafter until the fracture has healed.

**AMPUTATION**

Indications for amputation in small mammal include severe traumatic orthopedic conditions, unresolvable osteomyelitis, primary and metastatic bone tumors, and as a salvage procedure from failed fracture repair. Most small mammals, including rabbits, tolerate single limb amputation well even if it is a hind limb. For a forelimb amputation, most surgeons prefer removing the scapula as it is faster and more cosmetic; however, some surgeons leave the scapula to protect the thoracic wall. Hind limb amputation can be done through a disarticulation of the coxofemoral joint or a midfemoral approach, which is faster. Disarticulation of the coxofemoral joint is always performed if a neoplastic process is present in the femur. It is important to remember that rabbit bone shatters easily so a bone saw or Gigli wire are used to cut bone. Also, enough muscle and skin are left to facilitate a tension free closure over the bone. The incision is bandaged postoperatively to help decrease dead space and prevent seroma formation.

References are available from the author upon request.