FELINE ORTHOPEDIC SURGERY: THEY ARE NOT JUST SMALL DOGS

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INTRODUCTION
Over the last ten to fifteen years, attitudes towards pet care have progressed dramatically. Nowhere has this been as evident as in people’s attitudes towards cats. Today cats are living longer, healthier lives. With this, owners have begun to demand more advanced care for their feline pet. Although many aspects of canine care do cross over to the feline patient, the old adage “cats are not small dogs” holds more true today than ever. The area of feline orthopedics is no different. The purpose of this article is to familiarize the reader with the more common feline orthopedic problems.

DIAGNOSTICS
As with canine orthopedics, a good history and orthopedic exam are the cornerstone to making the correct diagnosis. Major differences include the cat’s willingness to cooperate and basic feline anatomy. Often times it is very difficult to get a gait analysis in the exam room. Most cats are reluctant participants when it comes to gait evaluation. They frequently are hesitant to walk and prefer to huddle in a corner or under a chair. Cats may walk if approached from behind or encouraged by their owner. It may be necessary to observe the cat though a window or from behind a door, or by having the owners bring a videocassette from home. For these reasons, historical information may provide valuable details about the affected limb. Additional dilemmas arise when trying to examine a cat that is painful or fractious. Sedation may be required after a complete physical exam, especially in trauma patients, and a brief orthopedic exam are performed. If possible, always attempt to localize which region of a particular limb is affected prior to sedation, including neurologic status. A complete orthopedic exam consists of careful, systemic palpation of all four limbs, generally examining the affected limb last. Palpation while standing, if possible, should be done first to assess any asymmetry that may be present. Always begin palpation of each individual limb at the toenails and work proximal to either the scapula or pelvis. Move each joint through a full range of motion, paying attention for limited movement, effusion, pain, or crepitus. Palpation of all muscle groups and each long bone should also be performed. Repeat any palpation that elicits an abnormal reaction, as it can be difficult to differentiate uncooperativeness with true discomfort. Remember to assess the neurologic status of the patient as well.

As with dogs, many diagnostic tools exist after completing a physical exam. Radiography is by far the most utilized tool in feline orthopedics. In most cases it is essential to have two orthogonal views of the area in question. Occasionally special views will also be needed (oblique, skyline etc.). Fluoroscopy is also a helpful modality when available. Some applications include locating metal objects for removal, contrast studies (arthrogram, myelogram) and intraoperative placement of pins or assessment of fracture alignment. Computer tomography and magnetic resonance imaging can also be valuable modalities in certain situations; however, they are relatively expensive and generally limited to large referral practices or veterinary teaching hospitals at this time. Nuclear imaging to detect inflammation or neoplasia can be very helpful in localizing lesions prior to additional studies. Ultrasonography has been used in cats on occasion to image tendons and soft tissue masses. Arthroscopy of the feline joint is also an excellent method of evaluating the feline shoulder, elbow and stifle.

IMPLANT SYSTEMS
The successful management of a fracture depends on proper diagnosis and planning. Several variables must be considered prior to selecting a method of repair. Size and age of the cat, as well as fracture type and concomitant soft tissue damage play a large role in selection of repair. Other factors that should be weighed are disease status of the cat, owner’s willingness to comply with postoperative management, and the cat’s temperament and environment. Cats’ that are allowed to return outside shortly after fracture repair will require different fixation than strictly indoor cats. The surgeon must also consider equipment availability, cost, and surgeon skill level. Successful fracture repair is a race between healing and implant failure. Therefore, the selection of an appropriately placed implant can be the single most important factor in outcome. Several implant systems have been used successfully in feline orthopedics.

Intramedullary (IM) pinning has been used for years to effectively stabilize fractures of long bones in cats. Pin types include Steinmann pins, Kirschner wires (K-wires), and Rush pins.
Steinmann pins are available in diameters from 1/16 to 1/4 inch, and may be threaded or smooth. Even large cats will rarely require a pin larger than 1/8 inch. K-wires are similar to Steinmann pins, with diameters of 0.035, 0.045, and 0.062 inch. Rush pins are introduced at an angle such that they flex, and are seated with two to three points of contact within the medullary canal. Since cats have straight bones, relative to dogs, it is possible to fill the entire medullary canal, and still maintain anatomic reduction. However, this may lead to disruption of medullary blood supply, and increase risk of delayed union. It is generally best to use a pin that is 60 to 75 percent of the medullary canal. Cerclage wire may aid fixation with IM pins, but they must be used appropriately to avoid complications such as non union and fixation failure.

Recently, studies have shown good success in the repair of some fractures in cats with interlocking intramedullary nails. The interlocking nail (IN) allows a more limited approach than bone plates, and provides adequate rotational and axial stability. This technique had been reserved for dogs, due to the diameter of available interlocking nails in veterinary medicine until the release of the Small Interlocking Nail System. This system contains nails of 4.0 and 4.7mm diameter, which are available in lengths of 68, 79, 91, 101, and 112mm. Each nail accepts 2.0mm screws in either three or four interlocking holes. Nails which contain only three holes will have only a single hole proximal or distal. This system also contains a jig and extension device to allow placement without fluoroscopy.

For years external skeletal fixation has been used to repair several types of fractures in cats. Many different types of external skeletal fixators (ESF) have been used, depending on the type and location of the fracture. Advantages of the external fixator include ease of application, minimal approach to the fracture, allowance for management of associated open wounds, compatibility with other fixation devices, it is well tolerated by cats, ease of removal, and lower cost to the surgeon and owner. In general, cats are too small to use the traditional Kirschner-Ehmer frames. Therefore, acrylic frames usually need to be fashioned as connecting bars. Selection of pin size is important, as pins too large can weaken the cortex. A good rule of thumb is to select a pin 20-30 percent the bone diameter, which in cats is usually between 0.035 and 3/32 inch. The most common type of fixator pin used in cats is a positive profile threaded pin, usually end threaded. A recent development in circular ring fixators may make placement of Ilizarov-type ring fixators, for congenital abnormalities, as well as fractures, in cats possible. The Miniature Circular External Skeletal Fixator provides 35mm rings with 0.035 or 0.045 inch K-wires.

Bone plates have long been used to repair fractures in humans, cats, dogs, and almost any other species. Size becomes the main difference when repairing a fracture in a cat or small kitten. Short bones with a narrow diameter prove to be a challenge when selecting the appropriate sized bone plate. Fortunately several different sets of plating equipment are available commercially. The Mini Fragment Instrument And Titanium Implant Set is equipped with 1.5, 2.0, and 2.7mm bone plates. These plates come as both straight and T-plates. Screws (1.5, 2.0, and 2.7mm) and accessories are also available. The Mini Bone Plating Set and Small Bone Plating Set provide bone plates that take screws ranging from 1.5 to 3.5mm. The smallest plates are 3.8 and 5.0mm wide and come as cuttable and dynamic compression plates. Dynamic compression plates (DCP) are available with a variety of hole positions relative to the shank, to allow easier application on proximal or distal fractures. Cuttable plates are weaker, but can be stacked to provide greater stability. Another application for cuttable plates in the cat is with the plate-rod technique. This technique combines a bone plate and an IM pin to provide stability. In cases of extremely small bones the authors’ practice has utilized the Modular Hand System to apply bone plates. These plates come in 1.0, 1.3, 1.5, 2.0, and 2.4mm sizes, as DCP, straight and T-plates. However, this system may be too expensive for purchase for occasional use, and may need to be reserved or borrowed from a local hand and finger surgery specialist.

**COMMON ORTHOPEDIC PROBLEMS IN CATS**

**Antebrachial fractures:** Feline antebrachial fractures were reviewed in a retrospective study of cases presented to two university teaching hospitals (Wallace AM et al, 2008). A high incidence of complications was noted, with 9/46 (19.6%) of cases requiring revision surgery. The most problematic fracture types were the combined diaphyseal and proximal ulnar fractures (Monteggia and olecranon fractures) with 23.1% and 30% of these cases requiring revision respectively. Open fractures and those with major comminution were significantly more likely to require revision surgery. Final limb function following recovery was assessed as good to excellent in 90.3% of cases. For the combined diaphyseal fractures, stabilisation of both bones proved an effective repair strategy with only 1/8 cases (12.5%) requiring revision versus 5/18 cases (27.8%) where only one bone was stabilised. For the
combined diaphyseal fractures the two main repair methods were external skeletal fixation (ESF) or radial plating. The success rate was greater for radial plating with only 1/10 (10%) cases requiring revision versus 4/14 (28.6%) for ESF. However ESF tended to be applied to the more complicated fractures. Synostoses and radiohumeral luxation were noted as complications associated with the fractures stabilised by ESF.

**Femoral fractures:**
Femoral fractures are common in cats accounting for 38% of fractures in one survey (1).

**Anatomy**
In cats the femoral intra-medullary canal is straighter and has a more uniform diameter over the length of the bone than in dogs.

**Intramedullary pinning**
In adult cats the medullary canal is fairly uniformly filled by a Steinmann pin (3-5mm). The pin should be placed in a normograde fashion from the intertrochanteric fossa to avoid risk of sciatic nerve damage. This results in the pin being placed more laterally. The pin should then be driven into the distal fragment until the tip of the pin is located level with the proximal half of the patella when the stifle is in a neutral position. The proximal pin is cut flush with the greater trochanter.

Rarely is the fracture suitable for IM pinning alone, unless the fracture interdigitates after reduction. An oblique fracture, where the length of the oblique part is at least twice the diameter of the bone, is suitable for cerclage wiring in combination with IM pinning.

Short oblique or transverse fractures may remain rotationally unstable when a single IM pin is used for fixation. Methods to reduce rotation include the addition of an external skeletal fixator (ESF), use of multiple pins (stack pins), a triangular nail, an interlocking nail or plate and screw fixation.

**Plate and screw fixation**
The veterinary cuttable plate is an ideal implant for use in both the feline tibia and femur. The 2.0mm DCP or mini T plate can be used for simple distal or proximal fractures. For severely comminuted fractures which are commonly seen in the cat the plate can be applied in the ‘Open But Do No Touch’ method (OBDNT). The fracture is stabilized enough to gain correct rotational and angular alignment and to maintain bone length but no attempt is made to reduce the small fracture fragments. Addition of an intramedullary pin should be considered to assist reduction and increase stability (Plate-rod technique). The aim of this technique is to leave the soft tissue envelope intact, thus minimally interfering with the blood supply and fracture healing.

**Interlocking nail**
The interlocking nail is useful for midshaft transverse or comminuted femoral fractures when there is enough bone distally and proximally for two (or one) screws. There are two sizes available for cats - 4.7mm and 4.0mm. These are used with 2.0mm screws. The advantage of this method of fracture stabilisation over plate and screw fixation is that there is less disruption to soft tissue and the pin is placed in the mechanical axis of bone – a biomechanically advantageous site.

Complications of femoral fracture repair
In a review of 26 cats, 6 of them (23%) had sciatic nerve entrapment. The cause of sciatic nerve damage was either due to direct trauma at the time of pin insertion or related to the fibrous tissue that formed around the pin tip. In all cases pins were inserted in retrograde fashion, left longer at the trochanteric fossa and placed more medially, compared to those without sciatic problems.

In a series of 22 cats with femoral fractures repaired by internal fixation, four cases of quadriceps contracture (18%) were observed.

**Tibial Fractures:**
Tibial fractures account for approximately 10% of long bone fractures in cats. In a survey of 73 feline tibial fractures by Richardson and Thacher they concluded that classifying fractures into mild moderate or severe can help establish a prognosis. Severe fractures (open and comminuted) took longer to heal and had a higher incidence of complications including infection, delayed union, malunion and non-union.
Species differences
The tibia is a long tapered bone in the cat with a slight S bend in it. Management techniques for fracture repair include external coaptation, intra-medullary pinning, plating and external skeletal fixation.

Bone Plates
Small bone plates can be used effectively to treat diaphyseal fractures of the feline tibia. Veterinary cuttable plates are particularly useful because of their size, versatility and ability to accommodate 1.5-2.7 mm screws. Intramedullary pins can be combined with plate and screws when using a biologic approach or to supplement stability. The addition of the intramedullary pin protects the plate from bending forces and decreases the chance of plate failure. Bone plates are applied to the medial surface of the tibia.

External Coaptation
Simple, non-displaced fractures may be suitable for external coaptation, particularly if the fibula is still intact. The advantage of this technique is that the blood supply is not disrupted by an open surgical procedure. However cats do not always tolerate casts well, the cast may slip, sores can develop and tendon laxity can result from the joint immobilization especially in the kitten. A simple 4 pin unilateral ESF will often prove to be a suitable and perhaps more satisfactory alternative.

Intramedullary pinning
The tapered nature and S shape of the tibia limits the diameter of pin to a fairly narrow one that can be used in this bone. The pin should be introduced in a normograde fashion. In transverse fractures rotation must be prevented with addition of an ESF or cerclage wires when appropriate.

Tibial Physeal Fractures
Distal physeal fractures – (salter harris type I or II). The distal fragment is very usually very small and thin. If there is minimal displacement external coaptation may be sufficient. Usually ORIF is preferable using two crossed K wires. External coaptation (cast or TESF) should then be provided until evidence of healing has been documented radiographically.

Complications
In Richardson and Thachers study the overall rate for osteomyelitis for 66 tibial fractures was 15%. The distal aspect of the tibia has relatively little surrounding soft tissue and risk of open fractures, displacement of fragments and avulsion of periosteum is higher than with other long bone fractures. These risk factors are associated with delayed fracture fragment revascularisation, inadequate callus formation, osteomyelitis and increased likelihood of non-union or delayed union. Placing autogenous cancellous bone graft around these distal tibial fractures is to be recommended.

Hip Dysplasia: Hip dysplasia in cats may be detected as an incidental finding when the pelvis or abdomen is radiographed for other reasons. The lower incidence, or detection rate, is related to the smaller size and varied genetic background of cats. In addition different clinical signs are exhibited. Pure bred cats may be predisposed. In one study the incidence was reported to be 6.6%(Keller et al 1999). Radiographic signs in cats included more acetabular remodelling with minimal femoral neck changes. A study performed at the University of Pennsylvania confirmed that cats have high hip joint laxity and there is a relationship between DJD and laxity in the hip joint of cats (Langenbach et al 1998).

Slipped Capital Epiphysis: Slipped femoral epiphysis (metaphyseal osteopathy)
This condition is seen mainly in young male neutered cats, aged 2 years or less. Affected cats present with a unilateral hind limb lameness often of insidious onset. Radiographs show a slipped femoral epiphysis, there may be ‘apple coring’ of the femoral neck (Queen et al 1998). This is a hypervascular response associated with attempts to repair the fracture. Biopsies of the affected femoral neck showed evidence of fracture healing. In some cases the fracture has healed but a malunion is present. One review of 26 adult cats with spontaneous femoral capital physeal fractures suggested that they were most likely to be heavier, neutered males with delayed physeal closure (McNicholas et al 2002). Treatment is femoral head and neck excision. The other femoral head may fracture at a later date.
Hip luxation (dislocation): Hip dislocation is a common traumatic injury in cats; it is the most commonly dislocated joint in the cat. The luxation usually occurs in a dorsocranial direction, mainly due to the pull of the gluteal muscles. Lameness may vary from non-weight bearing to mild with some external rotation of the foot. Manipulation, palpation and comparison of leg length can aid in diagnosis, however fractures in this area can have similar clinical findings. Definitive diagnosis is by radiography – lateral and ventro-dorsal extended. It is best to radiograph the hip joint prior to attempting closed reduction, if fracture fragments are present or the cat has hip dysplasia / DJD or another traumatic injury then closed reduction is unlikely to be successful. Treatment options include closed reduction, conservative, transarticular pin, ilio-femoral suture and femoral head and neck excision amongst others. The transarticular pin is a useful method of hip stabilisation in the cat, and the commonest technique we employ at CUVS. 1.6mm K wires are used, and left in for 2-3 weeks, the duration mainly dependant on the presence of other injuries. The prognosis is good for maintenance of reduction, except in bilateral cases where reluxation or of one hip is likely. Conservative treatment is an option in cats where cost is an implication, however stiffness is likely.

Cranial cruciate ligament disease
Cats do suffer cranial cruciate ligament disease. There are two main forms, traumatic and degenerative. In the traumatic form there is usually damage to other structures such as the collateral ligaments and menisci. Management of this latter condition will be discussed under the deranged stifle. Cats with degenerative cranial cruciate ligament ruptures (or the occasional isolated traumatic rupture) will have hind-limb lameness, stifle joint swelling and the cranial drawer test will be positive. Radiographs of affected stifles will show compression of the infra patella fat pad associated with a joint effusion. Meniscal calcification can be seen especially in older animals (Reinke & Mughannam 1994, Whiting & Pool 1985). In Reinke & Mughannams (1994) paper they report on six spayed female cats, five of which had a cruciate rupture. The lameness resolved after cruciate surgery and meniscal calcification resection. Calcification may also be present in the normal stifle. Treatment of cranial cruciate ligament rupture in cats is either conservative or surgical. Surgery may have the advantage of offering a quicker return to function and a decreased chance of osteoarthritis and meniscal damage. Generally extracapsular stabilisation techniques are suitable and the prognosis is good. TPLO and TTA has been reported to be effective in treatment of cats with cranial cruciate ligament tears as well. Meniscal tears have also been observed in uncomplicated cranial cruciate ligament tears. Partial meniscectomy results in a good outcome in these patients.

Patella luxation: Patella luxation is not common in cats, when it occurs it is generally medial and can be uni or bilateral. Both traumatic and developmental (congenital) forms are seen. The condition has been reported in the Devon and Cornish Rex, Persian and Abyssinians as well as domestic short-haired breeds (Engvall 1990). Houlton and Meynard (1989) report on 8 cats with patella luxation, six of which had bilateral disease. Conservative treatment was unsuccessful but there was a ninety percent improvement with surgery. One patella fracture occurred 6 months post operatively.

Patella fracture: Patella fractures in cats, if displaced, need surgical stabilisation usually with a pin and figure of eight tension band wire. If the fracture fragments are small then these can be resected and the injury treated similar to a patella ligament rupture (Harari et al 1990, Carb 1975, Brunnberg et al 1993). The latter can be repaired with a Bunnell type suture pattern threaded through a hole in the patella. Both repairs need protection with a wire suture placed through a hole in the tibial tuberosity and around or through a hole in the patella. TESF can be used but complications can occur if the cat is inadequately immobilised (Bruce 1999). Cats do have the radiographic appearance of bipartite and tripartite patella and these must be differentiated from acute patella fractures, although they may be chronic undisplaced fractures. If in doubt stressed radiographs are taken, with fractures the fragments should distract when the stifle is flexed.

Tarsal collateral ligament injuries
Traumatic hock injuries are common and usually associated with fractures. Occasionally cats will present with hind limb lameness associated with closed collateral ligament injury, often just the short collateral ligament may be ruptured. Prosthetic ligament reconstruction is recommended as primary repair is often difficult and ineffective. Anchorage of prosthetics is possible using small suture anchors.
References are available upon request