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FELINE ORTHOPAEDICS: CATS ARE NOT SMALL DOGS
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Introduction
Over the last twenty years, the veterinary community has prompted a dramatic improvement in the care of companion animals. Nowhere has this been as evident as in peoples’ attitudes towards cats. Today cats are living longer, healthier lives. With this, owners have begun to recognize health abnormalities and demand more advanced care for their feline pets. Although the broad principles of orthopedics are the same irrespective of species, cats are not small dogs, and important differences exist with respect to anatomical features and function as well as management of fractures and orthopedic conditions.

Sadly, the common misconception that the repair of feline long bones is simple to perform and not prone to the same range of complications seen in dogs is still strongly advocated in many members of our profession. It has been facetiously remarked that two cat bone fragments will heal if placed together in the same room. Unfortunately, this casual attitude is not borne out by clinical experience and studies, which have shown the cat to be susceptible to the same range of complications as the dog. The notion that feline fracture repair is straightforward may have arisen because of the cat’s ability to compensate for impaired function. This lecture provides an overview of the most common orthopedic conditions and methods of fracture repair in the cats with the emphasis on features that are pertinent to this species.

Diagnostics
As with canine orthopedics, a good history and orthopedic exam is the cornerstone to making the correct diagnosis. Unfortunately, due to the indoor/outdoor “lifestyle” of the majority of domestic cats, it is often impossible to obtain a reliable history from the owners. Major differences also include basic feline anatomy and the cat’s uncooperative nature. Most cats are reluctant participants when it comes to gait evaluation which is further complicated in the examination room. Cats are frequently 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, but often with a crouched or slinky gait. It may be necessary to observe the cat though a window or from behind a door, or by having the owners bring a videotape from home. For these reasons, historical information may provide valuable details about feline lameness and the affected limb. Further 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, for a complete orthopedic evaluation to be performed. If possible, it is always important to attempt to localize which region of a particular limb is affected prior to sedation, including neurologic status. A complete orthopedic exam consists of careful, systematic palpation of all four limbs, generally examining the affected limb last. Each joint should be checked through a full range of motion, paying attention for limited movement, effusion, pain response, instability or crepitus. It may be necessary to repeat any palpation that elicits an abnormal reaction, as it can be difficult to differentiate uncooperativeness from true discomfort. The neurologic status of the patient should always be assessed.

Although two orthogonal views represent the core of the radiographic examination, occasionally special views will also be needed (oblique, skyline, stress etc.). Fluoroscopy is also a helpful modality when available. 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. 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 nonunion 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 hole. This system also contains a jig and extension device to allow appropriate screw 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, ability to manage associated open wounds, and it is compatible with other fixation devices. ESFs are also well tolerated by cats, are easy to remove, and can be less expensive to the surgeon and owner. In general, cats are too small to use the traditional Kirschner-Ehmer or SK frames. Therefore, acrylic/epoxy frames usually need to be fashioned as connecting bars. Acrylic or epoxy connecting bars are not only lightweight, but are free-form allowing pins to be in multiple planes increasing bone purchase depending on the fracture configuration. 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 a mini circular ring fixator system may make placement of Ilizarov-type ring fixators or hybrid fixators possible for correction of congenital abnormalities as well as fractures, in cats. The Miniature Circular External Skeletal Fixator provides 35mm rings with 0.035 or 0.045 inch K-wires.

When plate osteosynthesis is chosen as the method of internal fixation, implants size becomes the major dilemma. Short bones with a narrow diameter prove to be a challenge when selecting the
appropriate sized bone plate. For many years, the most frequently used implant size was the 2.7 mm DCP for femoral, tibial and humeral fractures and the 2.0 mm DCP for radial fractures. Unfortunately both implants have shown to be suboptimal and frequent complications related to implant size and shape include stress protection, screws loosening, bending and breakage. Fortunately, there recently has been the development of more “cat friendly” implants which are available commercially. The Synthes Mini Fragment Set, now includes the 2.0/1.5 mm LC-DCP (limited contact plates) ranging from 4 holes (25mm length) to 14 holes (85mm length), and the 2.4/2.0 mm LC-DCP ranging from 4 holes (33 mm length) to 14 holes (113 mm length).

In particular, the 2.4 mm DCP stainless steel plate, has proven very successful in treatment of the cat’s long bones fractures (K. Zahn, U. Matis-2002). The limited bone–implant interface, the screws and plate size together with the interesting mechanical characteristics, make the 2.4mm a very adequate implant for the average cat size.

Another excellent implant is the Veterinary Cuttable Plate (VCP). The VCP is cuttable to the desired length, its stiffness is adjustable, it has a large number of holes per unit of plate length, it can be used with different size screws which can be adapted to the different size bones, and is also economical to use and stock. Two sizes of VCP currently available for use are the 1.5/2.0mm and the 2.0/2.7mm plates. These two plates differ in thickness and plate hole diameter but they have the same length (300 mm.), width (7 mm.) and distance between the plate holes centers. The Veterinary Cuttable Plate can be cut to the desired length with standard pin cutters (usually pin cutters for 2.5 diameter pins are sufficient).

One of the great advantages of the VCP is the possibility of increasing the degree of stiffness of the fixation by stacking (sandwiching) two plates of the same or different length and thickness. Stacking plates allows the surgeon to vary the plate rigidity according to the different fracture situation. Staking can be full length or partial with the top plate overlapping the bottom plate for three quarters or one half of its length. This change in the plate stiffness allows a more gradual stress distribution and decreases the stress risers at the end of the plate.

When stacking the veterinary cuttable plates, certain considerations should be kept in mind. When using plates of different thickness, the screw diameter is determined by the largest screw that will fit the smaller plate and the thicker and longer plate is always placed adjacent to the bone. The VCP are easy to contour making them adaptable to a wide variety of irregular shaped bones. If plates are to be stacked, they should be contoured simultaneously. Overlapping the two plates and inserting the largest size screw at each end of the plates minimizes slippage and eases the contouring procedure.

Among the advantages of the VCP is the large number of holes per unit of plate length which allows not only secure fixation of short bone segments but also permits the inclusion of small fracture fragments in the reconstruction that otherwise would be difficult to capture beneath the plate. VCPs can be placed in buttress fashion in cases of comminuted fractures that cannot be anatomically reconstructed. It is recommended to stack the plates to increase plate stiffness in order to avoid implant failure. A combined rod and VCP plate construct offers another excellent option.

Last but not the least, in this overview of “cat friendly implants” are the Locking Plates. Recent advances in the treatment of fracture repair in human and veterinary orthopedic surgery have led to the development of locking plates. Locking plates are fixed-screw angle implants where the screw locks into the plate either by a threaded or conical coupling mechanism and the standard cortical threads, which engage the bone. The locking plate systems can be likened in their function and behavior to an internally placed external skeletal fixator and offer certain advantages in fracture and osteotomy fixation over conventional plating methods. Locking plate systems increase the stability of the construct compared to traditional plates minimizing the amount of screws needed for adequate stabilization and do not require anatomic contouring of the plate simplifying plate application.

There are currently several different types of locking plate mini systems available including the Synthes LCP and the Fixin which may be an excellent method of fixation for the treatment of cat’s fractures.
The LCP mini system (2.0/1.5, 2.4, 2.7) is available in a wide range of standard straight plates as well as a variety of shaped plates.

The most interesting and differentiating feature of this system is the screw hole design, which is a combined locking and compression hole or “Combi” hole. The “Combi” hole allows the plate to be applied with either fixed angle locking screws in the threaded part of the combined hole or standard cortical screws that are placed in the dynamic compression unit (DCU) of the same hole. Application of the LCP with entirely locking self-tapping screws results in fixed-angle construct for superior fragment stabilization. Using standard cortical screws, in the case of a reducible fracture, is possible to apply dynamic compression across the fracture line. A specially designed drill guide is used for insertion of the locked screws to ensure appropriate screw placement of the bone to allow for the screws to adequately engage and lock into the threads of the plate. The standard AO drill guides are used for screws placed in dynamic compression fashion.

The Fixin System is a recently developed internal fixation device that is comprised of a stainless steel plate with threaded holes, titanium inserts that are screwed and locked into the hole of the plate and conical head screws which are locked into the corresponding conical hole of the insert by a conical coupling system. One disadvantage of the locking plate systems is the difficulty in removal of the implants, as the screw heads tend to fuse into the plate requiring transection of the screws between the plate and bone for removal. The coupling and insert design of the Fixin system allows easy implant removal if indicated after fracture healing by removal of the insert/screw combination from the plate via a specifically dedicated screwdriver. As will all locking plate systems, a specific Fixin drill guide allows for proper matching and locking between the conical head of the screw and the conical hole of the insert. The Fixin system is available also as a Mini set. The mini plates can accommodate 1.9mm or 2.5mm self-tapping screws. A complete set of more than 20 plates from linear to pre-contoured is available.

COMMON ORTHOPEDIC PROBLEMS IN CATS

Antebrachial fractures:
Feline antebrachial fractures were reviewed in a recent 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, stabilization 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 stabilized. 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 (you should include name and date).

Anatomy
In cats the femoral shaft and intra-medullary canal is straighter and has a more uniform diameter over the length of the bone than in dogs.
Intramedullary pinning
The straight conformation of the femoral shaft in adult cats is more amenable to intramedullary pinning compared with dogs as the medullary canal can fairly uniformly filled by a Steinmann pin (3-5mm). IM pins should be placed in a normograde fashion from the intertrochanteric fossa to avoid risk of iatrogenic sciatic nerve damage. 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.
IM pins function to resist bending forces placed on the fracture site, however an IM pin alone cannot resist rotational forces. Therefore, rarely is any 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, however, may remain rotationally unstable when a single IM pin is used for fixation. Methods to reduce rotational forces include the addition of an external skeletal fixator (ESF), use of multiple pins (stack pins), or plate and screw fixation (plate-rod fixation).

Plate and screw fixation
The veterinary cuttable plates, 2.0mm or 2.4mm DCP plates are ideal implants for use in both the feline tibia and femur. The mini T plate or L-plates can be used for simple distal or proximal fractures. For severely comminuted fractures of the femur, which are commonly seen in the cat, the plate can be applied in the ‘Open But Do No Touch’ method (OBDNT) or “Minimally Invasive” techniques. In these techniques, 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, minimizing the disruption of the fracture hematoma preserving blood supply to the fracture site and thereby improving fracture healing. The addition of an intramedullary pin should be considered to assist reduction and increase bending stability (Plate-rod technique).

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 diameter nails, with 2.0mm screws. Interlocking nails have the advantage over plate and screw fixation for fracture stabilization minimizing soft tissue disruption and increasing the fracture stabilization (area moment of inertia) as 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. Due to this high incidence of sciatic nerve injury, it may be useful to leave the IM pin long, extending from the greater trochanter with the intention of removing the pin with evidence of radiographic union, decreasing the potential of sciatic nerve injury and dynamizing the repair.
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 established a classification scheme – classifying the fractures into mild, moderate or severe which was predictive of 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 compared with moderate or mild fractures. Really? They had
mild, moderate and severe? Not simple moderate and comminuted? I couldn't find this reference on pubmed.

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 1.5-2.2 and 2.7 mm screws. The 2.0mm and 2.4mm DCP plates are also appropriate for tibial fracture stabilization. Bone plates are applied to the medial surface of the tibia. 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.

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 or bandages well, the cast may slip, sores can develop and tendon laxity, periarticular fibrosis and cartilage degeneration 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 feline 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 from the cranio-medial aspect of the tibial plateau. In transverse or short oblique fractures, rotation must be prevented with addition of an ESF, plate or cerclage wires when appropriate.

Tibial Physeal Fractures
Distal physeal fractures – (Salter-hHarris type I or II). The distal fragment is very usually very small and thin. If there is minimal displacement external coaptation may be sufficient. External coaptation (cast or TESF) should then be provided until evidence of healing has been documented radiographically. Usually open reduction and internal fixation is preferable using two crossed K wires to anatomically reduce and stabilize these fractures.

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 the 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 revascularization, inadequate callus formation, osteomyelitis and increased likelihood of non-union or delayed union. Placing autogenous cancellous bone graft around these distal tibial fractures is therefore 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 more likely detection rate compared to dogs, is related to the smaller size and varied genetic background of cats. In addition different, clinical signs are exhibited compared to dogs are often subtle and missed by owners.
Pure bred cats may be predisposed. In one study the overall incidence of feline hip dysplasia was reported to be 6.6% (Keller et al 1999). There also appears to be a weak association of hip dysplasia with concurrent medial patella luxation. In one study, 24% of cats with hip dysplasia also had medial patella luxation and the cats in this study were 3X more likely to have both abnormality compared to either disease alone. Radiographic signs in of hip dysplasia in cats include more acetabular remodelling with minimal femoral neck changes compared to radiographic signs in dogs. 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).

**Capital physeal fracture:** (metaphyseal osteopathy)
This condition is seen mainly in young male neutered cats, age 2 years or less. Affected cats present with a unilateral hind limb lameness often with an insidious onset. Radiographs show a slipped femoral epiphysis, there may be ‘apple coring’ or narrowing of the femoral neck (Queen et al 1998). “Apple-coring” is a hypervascular response associated with attempts to repair the fracture. Biopsies of the affected femoral neck are consistent with evidence of fracture healing. In some cases the fracture has healed but a malunion is present. The other femoral head may fracture at a later date. One review of 26 adult cats presenting 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 or total hip replacement.

**Hip luxation (dislocation):** Hip dislocation is a common traumatic injury in cats; it is the most commonly dislocated joint in the cat. (I don’t believe this. Would have either guessed tarsus or elbow!) Need reference – I have never seen one. 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 radiographic evaluation – lateral and ventro-dorsal extended views. 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, transarticular pin, ilio-femoral suture and femoral head and neck excision amongst others. The transarticular pin is a useful method of hip stabilization in the cat; 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 relaxation of one hip is likely. Conservative treatment is an option in cats where cost is an implication, however stiffness, loss of range of motion and gait changes are 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 concurrent damage to other structures such as the collateral ligaments and menisci resulting in stifle derangement. 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, similar to clinical findings in dogs. Radiographs of affected stifles will show compression of the infrapatella 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 stabilization techniques are suitable and the prognosis...
is good. TPLO and TTA procedures have also been reported to be effective in treatment of cats with cranial cruciate ligament tears. Similar to their canine counterparts, concurrent meniscal tears have also been observed in uncomplicated cranial cruciate ligament tears. Partial meniscectomy results in a good outcome in these patients.

In cats with stifle derangement, with the loss of multiple stabilizing structures, treatment is indicated by the injuries incurred. The tibia is often displaced caudally and proximally with the pull of the hamstring muscles and correction warrants open reduction and stabilization. An arthrotomy is indicated to assess the integrity of the collateral ligaments and for potential meniscal injury which are treated with partial meniscectomies. Collateral ligament tears are either primarily repaired, imbricated or prosthetic ligaments are placed for stifle stabilization. Cranial and caudal drawer from cruciate ligament damage can be stabilized with traditional extracapsular stabilization or tibial sling techniques. One case series including cats with stifle derangement adjunctively stabilized these joints with hinged transarticular external skeletal fixators after primary repair. The absolute need for adjunctive stabilization in these cases is uncertain.

**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. As previously described, patella luxation in cats is often associated with the presence of hip dysplasia.

**Patella fracture:** Patella fractures in cats, if displaced, warrants surgical stabilization, 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 immobilized (Bruce 1999). In a retrospective study of cats with patellar fractures, 86% of patellar fractures stabilized with k-wires and tension band resulted in further fracture or failure of fixation (Langely-Hobbs SJ, 2009).

Cats do have the radiographic appearance of bipartite and tripartite patella and these must be differentiated from acute patella fractures, although these may be chronic undisplaced fractures. If in doubt stressed radiographs are taken, with patellar fractures, the fragments should distract when the stifle is flexed.

**Tarsal collateral ligament injuries:**
Traumatic hock injuries are common and usually associated with fractures of the distal tibia, tarsal or metatarsal bones resulting in tarsal instability. 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.

**Humeral fractures:**
Humeral fractures in cats account for 5-13% of all fractures and most commonly affect the distal 1/3 of the bone. Stabilization of these fractures of often difficult due to the radial nerve crossing over the disto-lateral portion of the bone, the medial nerve and branch of the brachial artery which run through the supracondylar foramen, the cranio-caudal compression of the distal humerus and an intramedullary canal which ends much more proximal than in the dog.
Simple spiral, oblique and transverse fractures can occur in the humeral diaphysis as well as comminuted fractures secondary to gunshot injuries. These fractures can be stabilized with plate and screw fixation, interlocking nails, or external skeletal fixation. Intramedullary pinning is generally reserved for more midshaft fractures as it is impossible to pass the IM pin into the medial condyle/epicondyle, which is the technique recommended in dogs. The medullary canal also narrows significantly distally limiting the diameter of IM pin that can be placed.

Supracondylar fractures are often comminuted T-Y fractures and given the regional anatomy, make surgical repair challenging. These fractures can be stabilized with a unilateral external skeletal fixator especially if the distal fragment does not offer enough room for plate stabilization. If needed, a type II fixator or IM pin can be applied for added stability. Unilateral condylar fractures, commonly seen in dogs are unusual fractures in cats.

References are available upon request