Hind limb fractures are a common occurrence in small animals. Many options exist for fracture repair from placing a cast on simple diaphyseal fractures through to internal fixation of more complex fractures. The decision-making challenge for clinicians is to first determine which options are contraindicated for a particular fracture and then to determine which of the remaining options that are within the owner’s budget will have the best outcome.

This session will use several case studies to look at common hind limb fractures and focus on the practical aspects of decision-making to maximize success and minimize complications.

**Distal femoral physeal fractures in growing dogs and cats**

Distal femoral physeal fractures are relatively common fractures in immature dogs and cats up to two years of age.

In dogs, Salter-Harris II fractures occur most commonly followed by Salter-Harris I fractures.

In cats Salter-Harris I fractures are the most common form.

In distal femoral physeal fractures the epiphyseal / condylar fragment usually displaces caudally due to contraction of the gastrocnemius, semitendinosus and semimembranosus muscles. Both directions are possible however as shown in the images below in two separate cat fractures.
Open reduction of distal femoral physeal fractures and stabilization with crossed Kirschner wires (K wires) is necessary. The prognosis for healing is excellent due to the healing potential of immature animals and, provided that stable anatomic reduction can be achieved, function is also very good.

Various techniques have been described for repair of these fractures. The most commonly used method is crossed K wires inserted in a normograde manner from the lateral and medial epicondylar area. These can be placed through a standard lateral parapatellar arthrotomy approach. Extending the incision more proximally to expose part of the distal femur simplifies the surgery.

The large high friction surface area of the distal femoral physis and the interdigitation of the metaphyseal protuberances into the 3-dimensional “W” shape of the epiphyseal fossae provide very significant inherent stability - provided that anatomical reduction is achieved.

This image shows the distal metaphysis and the four cancellous bone prominences that “lock” into the epiphyseal condylar fragment once anatomic reduction is achieved.

It is very important to realise that this inherent stability is one of the features of this physeal fracture in immature animals. If the same fracture repair method were to be used in an adult dog with a distal femoral (non-physeal) fracture, the absence of this inherent stability greatly increases the risk of failure. So this simple fracture repair method of crossed K wires is only suitable in physeal fractures in immature animals.

To achieve anatomic reduction it is necessary to place a pair of bone holding forceps on the distal shaft of the femur and a pair of pointed reduction bone holding forceps symmetrically across the femoral condyle at the point of origin of the medial and lateral collateral ligaments. Apply careful traction to the two bone fragments and using a small elevator like a Freer elevator in between the two fragments to gently “lever” the two fragments back into reduction.

Accurate placement of the K wires is simplified if the femoral condyle can be clamped in temporary reduction once it has been anatomically reduced. To do this a second pair of relatively large pointed reduction bone holding forceps is placed longitudinally along the cranial surface of the femur. The proximal point of the forceps is anchored in a partial thickness hole in the cranial surface of the distal femur. The distal point is anchored in the proximal part of the intercondylar fossa.
These images below show reduction of the fracture (this is the left femur of a cat and proximal is to the left of the image) in the left image. The right image shows the same fracture after placement of the longitudinal pointed reduction forceps to temporarily maintain reduction while the K wires are placed.

Placement of the K wires is most easily done if the lateral pin is placed first. The pin is started immediately lateral to the long digital extensor (LDE) fossa and the LDE tendon as shown by the black circle in the image of the left femur of a dog below. The pin is directed proximally and medially to just exit the medial aspect of the distal femur.

Slow speed placement of the pin using an orthopaedic drill is necessary to prevent thermal necrosis of the bone as this will lead to bone resorption and early pin loosening. The other practical advantage of slow speed placement is that it makes it very easy to "feel" when the pin penetrates the cortex of the femur. Steady resistance is felt as the pin slowly traverses the cancellous bone of the femoral condyle. When the pin first engages the cortex of the femur increased resistance is felt because of the more dense cortical bone. Keep the same slow drill speed and you will feel an obvious drop in
resistance as soon as the pin tip penetrates the cortex. Stop at that point.

The medial to lateral pin is a “mirror-image” of the first pin. There is no landmark like the LDE tendon to identify the starting point for the pin in the medial condyle however if you start it in the mirror image position of the first pin it will be in the correct position.

Use of an aiming guide further simplifies pin placement as it increases accuracy.

The prognosis following anatomic repair of Salter-Harris I and II fractures is good to excellent. Closure of the distal femoral physis probably occurs in the majority of cases. In one study the only significant prognostic determinant for development of lameness associated with premature closure and femoral shortening was age at the time of fracture (Berg 1984). The distal femoral physis is reported to provide 75% of femoral longitudinal growth and closes between 6 and 8 months of age in dogs. Considerable breed variation occurs with regard to closure times. In a study of greyhounds 80% of femoral growth had occurred by five months of age and 95% had occurred by 7 months of age.

**Pelvic fractures in dogs and cats**

Pelvic fractures consequent to trauma are reasonably common in small animals. Both conservative and surgical options for fracture management exist. Unlike long bone fractures, non-union of pelvic fractures is a rare occurrence. This is because of the large muscle mass surrounding the pelvis, the low cortical : cancellous bone ratio of the pelvic bones and the simplified biomechanics compared to long bone fractures.

It is essential that animals with pelvic fractures are stabilised and assessed for concurrent soft tissue and neurological injuries prior to definitive treatment of the pelvic fracture. Radiographs of the thorax should be taken and urinary tract integrity assessed. Contrast studies of the urinary tract should be performed if urinary system integrity is in doubt. Radiographic views to assess the pelvis include a standard VD and lateral +/- oblique views.

The good biology and simpler biomechanics of pelvic fractures means that conservative options are more commonly possible than with long bone fractures. Clinicians need to understand the relative indications for surgical repair of pelvic fractures to determine which cases require surgery and which can be conservatively managed.

One of the key issues for owners to understand is that conservative management of pelvic fractures involves more morbidity for their pet than surgical repair and requires greater postoperative care. Effective
surgical repair of pelvic fractures limits morbidity, reduces the need for analgesics, speeds healing by providing stability across the fracture site and reduces the need for longer-term cage confinement.

General Indications for surgery in pelvic fractures

1. Acetabular fractures
Articular fractures are best managed surgically following the principles of repair of articular fractures. Conservative management of minimally displaced caudal acetabular fractures has been associated with good function. Comminuted acetabular fractures require some sort of salvage procedure.

2. Significant pelvic canal collapse – this is likely to lead to ongoing problems with constipation. If pelvic canal collapse is significant then effective surgical repair will improve or resolve the pelvic canal collapse. This applies to many sacroiliac luxations and ilial fractures and to some acetabular fractures. If major pelvic canal collapse exists, and the owners do not have the financial capacity for surgical fixation of the fractures to restore pelvic canal diameter, then euthanasia should be considered.

3. The need for early return to function / desire for best function / desire for least morbidity. Stabilisation of pelvic fractures greatly reduces morbidity and speeds return to function. Requirements for prolonged analgesia are greatly reduced, as is the need for prolonged cage confinement. Effective internal fixation of pelvic fractures allows early return to controlled weight-bearing function.

4. Multiple limb injuries - Stabilisation of pelvic fractures leads to early return to weight bearing and can reduce the load on contralateral limb injuries.

The above image shows the pre-op and postop radiographs of a dog with right-sided ilial and acetabular fractures that have caused collapse of the pelvic canal by about 40%. Reduction and stabilization of the fractures has restored the pelvic canal diameter, greatly reduced morbidity and allowed early return to function with a reduced requirement for long term analgesics.
The images below show a case with unilateral sacroiliac luxation and ischial and pubic fractures that has resulted in approximately 30% pelvic canal collapse. Placement of a single sacroiliac screw has restored the majority of the pelvic canal diameter.

Diaphyseal tibia fractures in dogs and cats

Tibial fractures occur commonly in small animals and may present in a variety of forms. Because of little soft tissue covering in the craniomedial aspect, open tibial fractures are common. Consequently the tibia has the second highest non-union rate after the radius (25% and 60% of all non-unions respectively).

The tibia is unique in being the only one of the long bones where all of the fracture repair options (external coaptation, IM pins and cerclage, external fixators, interlocking nails and bone plates) can be used. It is essential to consider the strengths and weaknesses of each fracture repair method when deciding on suitable options for repair of any tibial fracture.

External coaptation

The use of external coaptation is only suitable in tibial fractures with a very good biological and biomechanical fracture assessment score. This means incomplete “greenstick” fractures or simple transverse fractures in young animals that can be adequately confined. The comminuted distal tibial fracture pictured here in an adult cat would not be suitable for cast repair.

Casts are **unsuitable** on tibial fractures where:
bending and rotational forces of high magnitude (such as in large breed or very active dogs) are expected

- axial compression will be a major force such as in comminuted fractures or oblique fractures
- fracture healing is likely to be slow. It is challenging to keep a cast on a dog or cat with a tibial fracture without complications for more than 4-6 weeks.

Intramedullary pins

IM pins are only suitable in tibial fractures with a very good biological and biomechanical fracture assessment score. This means simple long oblique or spiral fractures in young animals that can be adequately confined.

IM pins should nearly always be used in combination with cerclage wire. The shape of the tibia means that cerclage wire is only suitable for use in the distal 1/3 of the tibia in dogs and the distal half of the tibia in cats.

Normograde pin placement is the only suitable method in the tibia. Tibial fractures should never be retrograded, because the pin will pass into the articular part of the stifle joint resulting in significant morbidity and ultimately marked degenerative joint disease.

Tibial pins should be introduced from the medial aspect of the proximal tibia. This location is within the capsular part of the stifle joint but is outside the synovial part of the joint.

When seating the pin in the distal tibia it is important to recognise that the tibial malleoli extend below the level of the talocrural joint. Measure from the preoperative radiographs to ensure that the pin is not penetrating into the hock joint.

Depth of pin insertion can be judged by a combination of “feel”, when the pin engages the cancellous bone in the far bone fragment, and more accurately judged by overlaying a pin of identical length.
Bone plates

Bone plates are very useful in the management of both closed and open tibial fractures.

Bone plates are applied to the medial aspect of the tibia. Making a cranial skin incision for the medial approach will simplify closure and prevent the skin being closed directly over the plate.

The small amount of soft tissue present on the medial aspect of the tibia means that minimally invasive surgical approaches for plate placement are well suited to the tibia.

Plate contouring is necessary due to the sigmoid shape of the tibia in a mediolateral and craniocaudal plane. The image here shows the slight contouring that is needed for tibial plate placement.

The use of the plate-rod technique is possible on the tibia though is technically more difficult than in the femur. The narrowest part of the tibia is in the distal half and the limited widening in the distal tibial metaphysis makes distal screw placement more difficult than with femoral plate rods.

External Skeletal Fixators (ESF)

The tibia is the easiest bone to apply an ESF to. It is recommended that surgeons developing their ESF technique should work first on the tibia before moving on to the radius and other long bones.

All types of ESFs (Types I, II and III and circular fixators) can be applied to the tibia although the absence of muscle mass along the medial aspect make this the ideal surface to apply type 1 and type 1b ESFs to as this limits soft tissue morbidity.

This image shows closed application of a Type 1b Imex SK ESF with carbon fibre connecting bars to the craniomedial aspect of the left tibia of a dog. Type 1b frames are ideal for use on the tibia in many tibial fractures.

With the advent of newer ESF technology the majority of tibial fractures that are suitable for repair with an ESF can be managed with Type 1 and Type 1b frames. These are applicable in both standard linear frames or as hybrid frames (in combination with a distal ring). Older style ESFs, including “traditional” Kirschner- Ehmer ESFs usually required a
Type 2 frame to achieve sufficient stability. This is not the case with newer technology frames that have better clamp and connecting bar designs.

Type 2 frames (pictured here) are commonly recommended as being ideal for use in the tibia however these have the disadvantage of requiring pin placement through the lateral muscle mass of the tibia. This leads to increased morbidity, earlier pin tract discharge and earlier pin loosening than when pin placement is confined to the medial and cranial aspect of the tibia such as with placement of a Type 1b ESF.