Management and treatment of feline tarsal injuries

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Feline tarsal injuries are common, particularly in male cats, and can result from dog bites, road traffic accidents or falls from heights. Complete physical and orthopaedic examinations are required to reliably identify all injuries in these cases, but life-threatening injuries must take precedence over orthopaedic trauma. This article discusses the management and treatment of injuries to the feline tarsus.

Anatomy

The feline tarsus is a complex structure that consists of the tibia, fibula and seven tarsal and four metatarsal bones, along with the ligaments and fibrocartilage that keep these bones together and aligned correctly (Fig 1). The five main articulations of the feline tarsus are the tarsocural joint (between the tibia/fibula and talus), the talocentral joint (between the distal talus and the central tarsal bone), the calcaneoquartal joint (between the distal calcaneus and the fourth tarsal bone), the centrodistal joint (between the central tarsal bone and tarsal bones 1 to 3) and the tarsometatarsal joint (between the metatarsus and tarsal bones 1 to 4) (Fig 2). The joints between adjacent tarsal bones are known as the intertarsal joints. The tarsocural joint is the high motion joint of the hock that accounts for the majority of hock extension and flexion; the remaining joints are low motion joints with only minimal extension and flexion (Voss and others 2009).

Numerous short ligaments span the small bones of the tarsus. The distal tibia and fibula are connected to each other by the tibiofibular ligament. The distal aspect of the tibia is known as the lateral malleolus, and the distal aspect of the fibula is known as the medial malleolus.

The medial and lateral malleoli oppose the trochlea of the talus and contribute to the tarsocural joint. The malleoli extend distally beyond the surface of the trochlea of the talus and prevent lateral and medial translation of the talus relative to the tibia and fibula. The malleoli are the point of origin of the medial and lateral collateral ligaments. Unlike dogs, cats do not have long collateral ligaments, only short ones, and the medial and lateral (short) collateral ligaments consist of straight and oblique branches. The oblique branch of the medial collateral ligament is known as the tibiotalar portion and is partially hidden deep to the medial malleolus. The straight branch of the medial collateral ligament is the tibiocalcaneal ligament and inserts on the dorsomedial process of the central tarsal bone (Fig 3).

The lateral collateral ligament has an oblique talofibular ligament, the origin of which is deep to the lateral malleolus. The calcaneofibular ligament of the lateral collateral ligament has a straight and oblique branch (Voss and others 2009) (Fig 4).

Patient evaluation

Tarsal injuries can result from dog bites, road traffic accidents or falls from heights. Tarsal injuries in male cats are overrepresented compared to female cats; tomcats have a wide home range and roam in search of oestrus females (Owen 2000, Rochlitz 2003). Complete physical and orthopaedic examinations are mandatory to reliably identify all injuries in these cases, but the recognition and management of all life-threatening injuries must take precedence over orthopaedic trauma. Common thoracic injuries include pulmonary contusions, diaphragmatic rupture, pneumothorax and haemothorax (Fig 5). The extent of pulmonary contusions may not manifest radiographically until 24 to 48 hours following trauma.

Wound management, including shear injury

The feline tarsus is prone to severe shear injuries and fractures, due to the paucity of soft tissue protection in this area (Earley and Dee 1980). Following patient stabilisation, basic first aid treatment is applied to distal limb wounds, including shear injuries. The patient is made comfortable using appropriate analgesia, including opioid and/or non-steroidal anti-inflammatory drugs (NSAID), sedation or a general anaesthetic as appropriate, depending on the status at presentation. Sterile gel is applied directly to the wound and the surrounding area is clipped generously. The wound itself should be flushed with isotonic fluid, such as 0.9 per cent saline or compound sodium lactate solution. This can be achieved using a 20 ml syringe, three-way tap and 18 gauge needle (Anderson 2009). Following wound flushing, a bacteriology swab should be taken and treatment with a broad-spectrum bactericidal antibiotic such as amoxicillin and clavulanic acid can be started, pending culture results. The wound can then be dressed or the injuries stabilised and treated as appropriate. Substantial costs may be involved during hospitalisation and management of wounds associated with shearing injuries (Kulendra and others 2011). For large lesions, free skin grafts can be used to prevent contracture of the joint and speed up wound healing times. External skeletal fixation can be applied concurrently with free skin grafts (Fig 4).
Preoperative radiographic examination

Following sedation or general anaesthesia, careful palpation of the tarsus gives an indication of the level and nature of instability present, after which radiographs are necessary to accurately characterise and define the instability. The normal tarsus of the cat will inherently have a degree of laxity present compared to dogs. If there are no tarsal injuries in the contralateral limb it can be used for comparison. Standard dorsoplantar and mediolateral radiographs give an initial overview and indication of gross fractures and instabilities present. However, subsequent oblique radiographs or, more usually, stressed radiographs are required to demonstrate all injuries present. It is essential to fully understand the nature and extent of fracture/instability before embarking on surgical stabilisation. Treatment options depend on the level and direction of the instability and concurrent fractures. Stressed radiographs can be taken by stabilising the proximal portion of the limb using ties and/or sandbags and stress is applied to the distal limb that is held in the stressed position using Sellotape or a tie attached to a sandbag if necessary. Stressed radiographs are taken in four dimensions in most cases, that is, valgus, varus, dorsal and plantar-stressed views. Survey and stressed radiographs of the contralateral tarsus may be useful for comparison.

Tarsocrural joint

The tarsocrural joint is the joint between the distal tibia, distal fibula and the talus. This joint can also be referred to as the hock joint and is the main point of extension and flexion of the distal pelvic limb. Tarsocrural instability is commonly seen in distal limb injuries in cats and occurs as a result of fractures and/or disruption of the previously described collateral ligaments (Roch and others 2009, Nicholson and others 2012). Because of the interdigitating shape of the distal tibia, medial and lateral malleoli and the trochlea of the talus, complete luxation requires either malleolar fracture or multi-ligamentous injury (Schmokel and others 1994) (Fig 7). Collateral ligament sprains are more common than avulsion fractures of the origin site of the ligaments, and collateral ligament sprains more commonly affect the medial than the lateral side (Fig 8). Due to the lack of surrounding soft tissue, the joint is also more prone to developing open fracture/luxations; about 65 per cent of tarsal injuries in cats are associated with open fracture luxations (Owen 2000).

Several options have been reported for treatment of tarsocrural luxations. Treatment options include primary repair of the ligaments, prosthetic ligaments, external coaptation and transarticular external skeletal fixator (TESF) application. Salvage options include pantarsal arthrodesis or amputation (Schmokel and others 1994, Roch and others 2009). Primary repair of the ligamentous structures can be difficult to impossible as the ligaments are very small, shredded and/or very difficult to identify. In addition, the tibiotalar and talofibular collateral ligaments are concealed deep beneath the medial and the lateral malleoli making access difficult or impossible. Prosthetic ligaments can be used to restore joint stability that is lost as a consequence of collateral ligament damage; the prosthetic ligaments are secured using either suture anchors or screws with washers. Alternatively, bone tunnels can be used to secure the suture material instead of metal implants such as screws or suture anchors (Nicholson and others 2012). Simple ruptures of the collateral ligaments can be treated with suture prostheses and external coaptation, but the degree of soft tissue injury may influence outcome with this technique (Schmokel 1994).

In cases where skin wounds are present over the medial and lateral malleoli, bone tunnels may be advantageous compared to screws or suture anchors, in order to minimise the rate of postoperative infection associated with metal implants. Staphylococcus aureus is a common cause of orthopaedic infections, as a result of contamination from the skin, and the use of metal implants, soft tissue injury or dissection can potentiate infection (Dunning 2003).

External coaptation can be used to manage tarsocrural instability, but it is inconvenient and cumbersome for wound management, is often poorly tolerated and can lead
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The calcaneofibular ligament, which is made up of an oblique and a straight branch

Fig 4: The lateral collateral ligament consists of the oblique talofibular ligament and the calcaneofibular ligament, which is made up of an oblique and a straight branch.

Fig 3: The medial collateral ligament consists of: the tibiotalar ligament, partially hidden deep to the medial malleolus, and the tibiocentral ligament, which inserts on the dorsomedial process of the central tarsal bone.

Stabilisation of malleolar fractures can be achieved with Kirschner wires (K-wires) (Fig 9), pin and tension band technique or lag screws (Piermattei and others 2006). In feline patients, the fragments of fractured bone are often very small; therefore, stabilisation with implants, particularly lag screws, may prove difficult and often risks further fracturing of the bone. As malleolar fractures involve the articular surfaces of the tarsocural joint, it is important that the basic principles of articular fracture repair are observed, that is, rigid fixation, compression and accurate reduction so that normal anatomical alignment is established and bone healing occurs without callus formation (Schwarz 2005). Depending on the size of the malleolar fragment, one or more K-wires can be used. Following internal fixation and tarsocural stabilisation, application of a padded support dressing, such as a modified Robert Jones dressing, may be considered for three to four weeks postoperatively.

TESF is typically used to achieve tarsal stabilisation either on its own, or to protect surgical stabilisation techniques such as prosthetic ligament placement. Use of a TESF to protect a surgical stabilisation is frequently a matter of surgeon preference, because rigid immobilisation with a TESF may not be necessary if the tarsocural instability is sufficiently and reliably stabilised using internal fixation techniques such as K-wires, lag screws, pin and tension bands, or prosthetic ligaments. A variety of configurations of TESFs can be used, including type I (uniplanar, unilateral with or without a triangulation cross bar) or type II TESF (uniplanar, bilateral, Fig 10), but TESF can be cumbersome for cats, particularly when larger TESF frames are used. To minimise TESF frame size, the sturdier but bulkier type II TESF frame can be substituted with a type I TESF plus triangulation cross bar. A minimum of three pins above and below the tarsus is recommended (Kulendra and others 2011). TESF is effective in achieving hock stability in cats with tarsocural luxation as it allows either malleolar fracture healing or fibrous scar tissue to form across the joint in the region of the ruptured collateral ligaments.

In cats, the hock should be fixed at an angle of approximately 100 to 110 degrees with a TESF (Voss and others 2009). Short-term rigid joint stabilisation allows limited flexion and extension of the tarsus, achieving adequate joint stability. However, longer-term rigid fixation can have deleterious effects on joint physiology, because immobilisation of the joint can lead to loss of synovial fluid production, bone mineral content and bone mineral density, and loss of range of movement (Jaeger and others 2005). Typically, TESFs are maintained for a period of four to eight weeks; malleolar fracture healing in cats has been shown to be complete in 80 per cent of cases between four and eight weeks (Earley and Dee 1980, Jaeger and others 2005). Re-mobilisation of the joint after TESF removal may allow reversal of some of the deleterious changes to the joint will be permanent. However, the clinical outcome of cats treated with TESF is often very good with 85 per cent of owners reporting excellent satisfaction following treatment (Kulendra and others 2011). To overcome the problem of bone mineral and articular cartilage degradation, hinged TESF can be used to achieve joint stability with controlled limited joint movement in the normal plane; for example, flexion and extension only. The hinged TESF has been used in the management of tarsal injuries in cats and dogs. The loss in range-of-motion of the joint with a hinged TESF was 28 per cent compared to the normal contralateral limb and, following removal of the hinged TESF, loss of range-of-motion was reduced to 16 per cent (Jaeger and others 2005).

With appropriate treatment and management of cases of tarsocural fracture luxation/instability, the prognosis for these injuries can be good to excellent. However, it should be recognised that in patients with associated soft tissue injuries, a longer duration of hospitalisation and greater financial commitment is often necessary (Roch and others 2009, Kulendra and others 2011).

Tarsometatarsal and calcaneoquartal joint

Numerous plantar ligaments are located on the plantar (tension) aspect of the tarsus. One of the main plantar ligaments originates from the distal aspect of the...
calcaneus and inserts on the fourth tarsal bone and the base of the fourth metatarsal bone (Voss and others 2009). Numerous short ligaments also span the individual tarsal joints. Injury to the main plantar ligaments results in calcaneoquartal subluxation and a plantigrade stance (Fig 11). Conservative management of such injuries is unsuccessful because of the high tensile forces generated by weight bearing that exceed the breaking strength of healing fibrous scar tissue. It is important to differentiate between calcaneoquartal luxation and damage to the common calcaneal (Achilles) tendon. In cases of calcaneoquartal luxation, cats typically present with a tarsus that is unstable mid body; instability is present on tarsal flexion and extension when the calcaneal tuber is grasped with one hand and the proximal metatarsus with the other. By comparison, disruption to the common calcaneal tendon results in hock hyperflexion, the tarsus can be flexed and extended independently when the stifle is maintained in extension and there is a palpable soft tissue swelling or defect of the distal common calcaneal tendon.

Injury to the short distal plantar ligaments can result in tarsometatarsal luxation, though this is relatively unusual without concurrent fracture of either the distal (numbered) tarsal or proximal metatarsal bones. Surgical treatment is recommended for medial, lateral and plantar instability. Sacrifice of the low motion intertarsal and tarsometatarsal joints by performing partial tarsal arthrodeses results in excellent functional outcome for both calcaneoquartal and tarsometatarsal injuries. Tarsal fracture/instability requiring calcaneoquartal and/or tarsometatarsal arthrodeses are usually achieved by application of a laterally positioned dynamic compression plate or hybrid arthrodesis plate. Alternatively, calcaneoquartal plantar instability can be stabilised using a pin or lag screw placed through the calcaneus into the fourth tarsal bone and a plantarly placed tension band. Dorsal plating with the ComPact Unilock 2.0/2.4 plate has been reported to treat dorsal tarsal instability with concurrent medial or lateral instability. In specific circumstances of dorsal instability, early implant removal may preserve joint function rather than achieving arthrodesis (Voss and others 2004).

Fig 5: Lateral (a) and dorsoventral (b) thoracic radiographs of a cat with tarsal trauma and concurrent diaphragmatic rupture; there is loss of the diaphragmatic outline, border effacement of the cardiac silhouette, evidence of a pleural effusion and displacement of gas-filled intestinal loops into the hemithorax

Fig 6: The feline tarsus is prone to severe shear injuries and fractures (a). For large lesions, skin grafts can be used to prevent contracture of the joint (b) and speed up wound healing (c)
If only dorsal instability is present, conservative management may be a viable option as long as the tarsus is relatively stable because, during weight bearing, the dorsal aspect of the tarsus is compressed and therefore stable. Such injuries can fibrose and heal with external coaptation alone. Medial, lateral and plantar instability must be ruled out with appropriate preoperative imaging and careful physical examination.

**Talocalcaneal joint**

Talocalcaneal luxation is a relatively uncommon injury in which dorsal displacement of the distal head of the talus occurs as a result of concurrent talocentral and talocalcaneal subluxation (Fig 12). This injury is a result of disruption to the talocalcaneal and talocalcaneal intertarsal ligaments. It is important to perform stressed radiographs to rule out concurrent instability of the tarsus. Surgical treatment involves placement of a positional screw from the talus into the calcaneus or talocentral arthrodesis (Voss and others 2009).

**Salvage procedures**

Depending on the nature and severity of injuries, and other factors such as owners’ financial constraints and willingness to consider the possibility of multiple surgical procedures, joint preservation may not always be a realistic goal. If the joint cannot be preserved, then salvage procedures to consider include either pelvic limb amputation or arthrodesis. An arthrodesis is defined as ‘the irreversible surgical fusion of two or more bones of a joint’ (Johnson and others 2005). If the tarsocural joint requires arthrodesis then a pantarsal arthrodesis should be performed (all joints at all levels of the tarsus) because arthrodesis of the tarsocural joint alone has been shown to lead to a poorer functional outcome compared to pantarsal arthrodesis (Gorse and others 1991). The tarsocural joint is the high motion joint of the tarsus and fusion of this joint alone results in excessive strain on the remaining low motion tarsal joints, which are not designed to tolerate higher ranges of movement.

Indications for pantarsal arthrodesis include unreconstructable articular fractures of the tibia or talus, tarsocural luxations that cannot be stabilised, severe instability of the tarsus and end stage degenerative joint disease. Less common indications include treatment of postural deformities secondary to peripheral tibial or peroneal nerve damage, and loss of integrity of the common calcaneal tendon (Vannini and Bonath 2005). Arthrodesis is accomplished by removal of all articular cartilage, using either a burr or curettage, and bone grafting to promote rapid and complete healing of the joint. Sources of autologous bone graft include the proximal tibia, ilial wing, proximal humerus and distal femur. Alternatively, commercial sources of feline allograft have recently become available, including osteoinductive demineralised bone matrix (Veterinary Tissue Bank). For pantarsal arthrodesis, the tarsus is set at a functional angle; the recommended angle varies depending on the reference source, and can be judged from the normal standing angle of the contralateral healthy pelvic limb and is typically 100 to 125 degrees (Vannini and Bonath 2005; Voss and others 2009). Finally, the tarsus is rigidly immobilised by internal or external fixation.

Pantarsal arthrodesis is commonly performed by application of a plate to the medial aspect of the tibia and tarsus. Significant bending forces are concentrated...
at the hock, which increases the chances of implant failure. Failure to incorporate the calcaneus into the pantarsal arthrodesis can lead to incomplete fusion of the talocalcaneal and calcaneoquartal joints and either lameness or arthrodesis failure. To prevent this, the mechanical strength of the plate can be augmented by application of a positional screw between the tibia and calcaneous or an intramedullary pin placed across the tarsocrural joint and up through the tibia (Kirsch and others 2005). Alternatives include a dorsally or laterally applied plate to the tarsus. A novel dorsally applied precontoured plate has been described; despite the plate being biomechanically weak as it is on the compression surface rather than the tension surface of the joint, initial results have been promising (Fitzpatrick and others 2010). If infection or wounds are present, then an external

Fig 9: Stabilisation of malleolar fractures can be achieved with pin and tension band technique or lag screws, or with Kirschner wires (K-wires) as shown in (a) and (b)

Fig 10: A uniplanar, unilateral type I TESF (a) and a uniplanar, bilateral type II TESF (b). TESF is typically used to achieve tarsal stabilisation either on its own, or to protect surgical stabilisation techniques, such as prosthetic ligament placement
A fixator can be used to achieve pantarsal arthrodesis rather than internal fixation, but joint compression (one of the important principles of arthrodesis) may not be as effective with an external fixator.

Complications associated with pantarsal arthrodesis include implant loosening, implant breakage and osteomyelitis. In the dog, the very serious postoperative complication of plantar soft tissue necrosis can result in significant skin/soft tissue sloughing; this has been suggested to be because of damage to the perforating metatarsal artery as it courses in between the proximal aspect of metatarsals 2 and 3 (Roch and others 2008). Although this complication has not been reported in the cat, the anatomy between the two species is sufficiently similar to speculate that plantar necrosis may occur in the cat as well. Alternatively, if plantar necrosis is instead a soft tissue dressing-associated injury, cats would be equally susceptible to this injury as dogs. Other complications include surgical site infection and failure to achieve arthrodesis.

**Summary**

Before considering and addressing tarsal injuries, it is important that the patient is fully assessed so that life-threatening injuries are recognised and treatment of these is prioritised. Once the patient is stabilised and judged to be well enough to undergo anaesthesia, full diagnostics and definitive treatment of tarsal injuries can be performed. Following a thorough physical and orthopaedic examination, survey, stressed and oblique radiographs can be used to identify fractures, luxations and the level and direction of instabilities present. Following identification of the nature of the injuries, it is possible to formulate an appropriate plan for management of these cases.

**References**


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**Fig 11**: The mediolateral radiograph (a) shows soft tissue swelling, widening and subluxation of the calcaneoquartal joint (CQ) compared to the normal tarsus (b). Malalignment of the calcaneus with respect to the distal tarsus is also visible.

**Fig 12**: Mediolateral (a) and dorsopalmar (b) radiographs of the tarsus. Radiographs show dorsal displacement of the talus with concurrent talocentral luxation and talocalcaenal subluxation. There is also a small chip fracture visible adjacent to the cranial aspect of the distal tibia.


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Further reading


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Self-assessment test: diagnosis and treatment of feline tarsal injuries

A one-year-old female neutered domestic shorthair (DSH) cat presents to your clinic non-weight-bearing on the right pelvic leg. The cat has been missing for the last three days. There is marked pain, malalignment and crepitus at the level of the tarsus. Physical examination and thoracic radiographs were unremarkable. Survey radiographs of the tarsus can be seen on the right. Classify the nature of the injury and outline an appropriate treatment plan.

A model answer can be found on page 132
A dorsoplantar and mediolateral radiograph of the tarsus reveals marked lateral and caudal displacement of the distal limb. The tarsocrural joint remains intact, but a physeal fracture (Salter Harris type I) of the distal tibia and a distal diaphyseal fracture of the fibula are present; as a result, there is most likely injury to the tibiofibular ligament. The medial aspect of the distal tibial metaphysis appears to be just beneath the skin; there is no evidence of gas in the soft tissues, suggesting the fracture is closed, but the skin in the region should be carefully checked for wounds. Treatment options to consider include placement of a crossed K-wire (one each medially and one laterally) and/or an intramedullary fibular K-wire driven distal to proximal. Alternatively, an external skeletal fixator could be applied after fracture reduction, but this will immobilise the hock joint and, therefore, would not be ideal.

Following surgical stabilisation, consider a postoperative dressing to control soft tissue swelling for one week, and for four weeks postoperatively to provide support to the surgical repair. In addition, cage rest for the first four to six weeks until follow up radiographs are performed should be advised.

In this case, a medial and lateral K-wire were placed in the medial and lateral malleoli (crossed K-wire). Following placement of the K-wires, the joint was assessed for any instability intraoperatively and none was found. The foot was placed in a support dressing with a medial and lateral finger splint for four weeks. The implants were left in situ as the cat had very little residual growth. After four weeks, the dressing was removed and the cat’s lameness had resolved.
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