Case Report

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Successful Management of Quadriceps Contracture in a Cat Using a Dynamic Flexion Apparatus

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Introduction
Quadriceps contracture is a muscular condition characterised by stifle hyperextension and atrophy of the quadriceps muscles. In cats, the condition is commonly diagnosed after mid-diaphyseal fractures of the femur (1). The proposed causes of quadriceps contracture include the development of a large bony callus, damage to muscles, nerves or blood supply during trauma or fracture repair, delayed repair or inadequate fixation of femoral fractures, and osteomyelitis (1-4). A number of degenerative changes occur in articular and periarticular tissue, as sequelae to quadriceps contracture, which may be reversible if the condition is recognised and treated early (5, 6). Conservative and surgical treatments have been unrewarding in the management of quadriceps contracture in the dog (2-8). Recently, a dynamic flexion apparatus was used successfully in the management of quadriceps contracture in a dog (9). This report describes the management of quadriceps contracture in a cat, following biological repair of a comminuted, mid-diaphyseal femoral fracture, using a dynamic flexion apparatus and intensive physiotherapy program.

Case Report
A six-month-old domestic short hair cat was referred for assessment of a left pelvic limb lameness 12 hours after an automobile trauma. The clinical and musculoskeletal examination revealed an unstable fracture of the left femur, pain on manipulation of the left femur...
and hip, and a full thickness skin wound along the cranial aspect of the distal left thigh.

On conscious thoracic radiographs a mild pneumothorax was detected. Radiographs of the left pelvic limb revealed a highly comminuted diaphyseal fracture of the left femur, cranio-dorsal dislocation of the left coxofemoral joint, subluxation of the left sacroiliac joint and separation of the pubic symphysis (Fig. 1).

Due to the presence of air around the fracture site and a large bone fragment adjacent to the skin wound a grade I open fracture was diagnosed. The skin wound was clipped, lavaged with 0.05% chlorhexidine diluted in isotonic saline, and covered with a sterile gauze swab soaked in 0.05% aqueous chlorhexidine.

The cat was anaesthetised for surgical reduction and stabilisation of the left coxofemoral luxation and femoral fracture. Open reduction of the hip luxation was performed using a cranio-lateral approach. The femoral head was reduced into the acetabulum and the joint capsule was closed with five preplaced simple interrupted sutures of 2-0 polydioxinone (PDS, Ethicon).

The incision was then extended along the lateral aspect of the femur and the fracture was exposed by retracting the vastus lateralis muscle cranially and the biceps femoris muscle caudally. Multiple lacerations, with embedded devitalised fragments of cortical bone, were observed in the quadriceps muscles. Three bone fragments, without any soft tissue attachments, were removed and crushed into two to three mm chips with rongeurs, and later returned to the fracture site to act as an autogenous bone graft. A sample of tissue was collected from the fracture site and submitted for Gram staining and culture and sensitivity. The proximal and distal fragments of the femur were maintained in spatial and rotational alignment, using two stacked 2.0/2.7 mm veterinary cuttable plates in a bridging fashion. A 2.0 mm cortical screw was initially used in the distal fragment in the bone plates adjacent to the fracture site. This screw stripped during insertion and was replaced with a 2.7 mm cortical screw and supplemented with a full cerclage wire. Post-operative radiographs showed adequate alignment of the left femur and reduction of the coxo-femoral dislocation.

The cat was cage rested for 14 days. Bacteria were not isolated from the tissue sample collected during surgery but the cat was treated with a 14 day course of amoxycillin-clavulanic acid (Clavulox, Pfizer Animal Health) and enrofloxacin (Baytril, Bayer) due to pyrexia that persisted for eight days post-operatively.

The animal was weight bearing, without lameness, four weeks post-operatively. Pain was not elicited on palpation of either the stifle or the femur but the degree of movement in the stifle was not measured.

Eight weeks after the operation, the cat admitted suffering an abnormally extended left stifle but it was still able to bear weight and ambulate on the affected limb. A musculoskeletal examination revealed atrophy of the left quadriceps muscle group, left stifle pain and marked reduction in the range of motion of the left stifle, especially upon flexion. The left stifle could only be flexed to a maximum of 120° compared to 27° in the normal right stifle. The range of motion in the left stifle was 35° compared to 128° in the normal right stifle. The range of motion in the hip joint was normal and, although not measured, the hock joint was mobile and was not hyperextended. Radiographs showed adequate progression of fracture healing and prominent callus formation (Fig. 2). A diagnosis of quadriceps contracture was made.

The cat was anaesthetised for surgical release of the quadriceps muscles and the application of a dynamic flexion apparatus. A lateral approach to the femur was performed. The vastus intermedius muscle was found to be adhered to the fracture callus. These adhesions extended along the cranial and medial aspects of the femur and were associated with an unreduced, medially displaced bone fragment. The fibrous adhesions were released using a combination of sharp, blunt and digital dissection. An autogenous fat graft was inserted between the femur and the quadriceps muscles. The degree of maximal flexion improved from 120° pre-operatively to 45° following release of the adhesions and intra-operative stretching of the quadriceps muscle group.

A dynamic flexion apparatus was used to immobilise the stifle in maximal

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Fig. 1. Lateral (a) and ventro-dorsal (b) radiographic views of the pelvis and left femur. There is a comminuted fracture of the left femur, cranio-dorsal dislocation of the left coxofemoral joint, subluxation of the left sacroiliac joint, and separation of the pubic symphysis. Note the radiolucent areas around the fracture site. This is indicative of the presence of air associated with an open fracture.
flexion, to stretch and lengthen the quadriceps mechanism, and permit periods of partial and full extension of the stifle with exercise and passive physiotherapy. A full, 3/32 inch positive profile pin (Imex Centerface Pin, Apex Laboratories) was inserted from a medial-to-lateral direction in the distal tibia and two clamps applied medially and laterally. A segment of polyester tape (Sherwood Davis & Geck) was tied to both of the clamps and looped onto the plantar aspect of the pelvic limb. Initially, two unsuccessful attempts were made at constructing the proximal component of the dynamic flexion apparatus. Due to the proximity of the bone plate a half-pin could not be inserted into the proximal femur. As a result of inadequate holding power and excessive tension from elastic bands flexing the stifle, a half-pin projecting caudally from the ischium loosened after two days. Hence, a type I external fixateur was inserted into the left pelvis with two non-threaded, 3/32 inch half-pins (Smooth Steinmann Pin, Apex Laboratories) into the body of the ilium and just cranial to the hip joint and one positive profile, 3/32 inch half pin (Imex Interface Pin, Apex Laboratories) was placed in the ischium. The pins were joined with a curved connecting bar and small connecting clamps. A ‘key-ring’ clip was placed on the ischial half-pin in order that elastic bands could be passed between the tibial pin and the pelvic external fixateur.

A physiotherapy program was then designed to maximise the stretching of the quadriceps muscles and also use of the leg. The polyester tape, attached to the distal tibial pin, was hooked directly into the clip on the pelvic fixateur for two one-hour periods every day (between 8 and 9 am and 4 and 5 pm) in order to maximise flexion of the stifle (Fig. 3). The cat was permitted to freely use his leg for seven hours each day (between 9 am and 4 pm) in order to encourage use of the leg. An elastic band (Superior Rubber Bands, Esselte) was folded around the polyester tape and hooked into the clip on the pelvic external fixateur for 15 hours each day (between 5 pm and 8 am) in order to encourage active extension against the tension of the elastic band, when walking, and to maintain the stifle in flexion during rest periods (Fig. 4). In addition, passive physiotherapy was performed four times daily with 30 repetitions of stifle flexion and extension. The cat tolerated both the dynamic flexion apparatus and physiotherapy program with a minimal amount of distress.

During the post-operative period, the range of motion in the left stifle was 130°, which was equal to the right stifle, with 155° in extension and 25° in flexion. When conscious, the calcaneus was able to contact the ischiatric tuberosity with the hock extended (Fig. 5). The cat used his left pelvic limb without any lameness or difficulty in running or jumping. The physiotherapy program was changed to flexing the stifle, in order that the calcaneus contacted the ischium, for 10 repetitions of 20 seconds, three times each day. The system was maintained for a further four weeks.

The cat was examined nine months post-operatively and six months after diagnosis of quadriceps contracture. He did not have any evidence of lameness, gait abnormality, or stifle pain. Gonio-metric measurement of left stifle suggested there was a lack of any change in the range of motion: 155° in extension and 25° in flexion. However, when conscious, there was a 7.0 mm separation between the calcaneus and the ischium when the stifle was flexed and the hock extended. This minor reduction in full flexion may have been the result of hypertrophy of the hamstring muscles or a greater resistance to manipulation of the leg when the cat was conscious. Radiographs of the affected leg showed remodelling of the femoral fracture.
Discussion

Feline quadriceps contracture is most frequently seen following femoral fractures in young cats (1, 10) but it has also been reported as a congenital condition (2). There have been six reports of quadriceps contracture in the cat but none were treated (1, 10). To the best of the authors' knowledge, this is the first report of successful management of quadriceps contracture in a cat.

Femoral fractures are the most common fracture in the cat, accounting for up to 26% of all fractures (11). Fractures may be repaired using either mechanical or biological approaches. Biological repair of comminuted fractures is recommended as there is a high risk of implant failure, non-union, and osteomyelitis if complex fractures are treated with anatomical reconstruction and interfragmentary stabilisation.

The aim of biological repair of comminuted fractures is to preserve soft tissue and blood supply, to enhance healing, while at the same time rigidly stabilising the bone in axial and rotational alignment using either an external fixateur, interlocking nail or a bridging plate (12, 13). Stacked veterinary cuttable plates have been used with excellent results for bridging osteosynthesis in comminuted diaphyseal fractures of the femur in cats (14). Comminuted femoral fractures treated with bridging plates have been associated with more rapid healing and fewer complications than similar fractures treated with anatomical reconstruction and plate fixation (12). However, as highlighted in the present case, a potential complication with biological repair of comminuted femoral fractures in immature animals is quadriceps contracture due to poor fragment reduction and prolific callus formation.

Clinically, quadriceps contracture is characterised by hyperextension and a reduced motion of the stifle associated with the quadriceps muscle group being atrophied, firm, and cord-like (3, 5, 9). The range of stifle motion in the present case was only 27° and, in dogs, has been documented between 10° to 30° (3, 5). Tarsal hyperextension was not observed in the present case, but it has been reported in other cases, as the result of pathological hyperextension of the stifle and passive tension of the gastrocnemius muscle (9). Other abnormalities include: medial patellar luxation, proximal displacement of the patella in the trochlea groove, limb shortening and hip subluxation or luxation (3, 5, 10).

The initiating factor in the development of quadriceps contracture is fibrous adhesions between, or incorporation of, the vastus intermedius into the healing fracture callus along the cranio-lateral aspect of the femur (1, 5, 9, 10). A large bony callus can develop secondary to a young and active periosteum, instability between fracture fragments, or periosteal stripping during either initial trauma or surgery (1, 9). In the present case, fibrous adhesions developed between the quadriceps muscles and a prominent bony callus, associated with a medially displaced bone fragment. Initial trauma to the quadriceps muscles, poor fragment reduction and extensive callus formation are all possible causes of quadriceps contracture in the case presented.

Generally, the treatment of quadriceps contracture has been unrewarding (3, 6). The aim of treatment is to restore stifle movement by freeing adhesions...
between the vastus intermedius and distal femur, lengthening the quadriceps mechanism, and releasing peri-articular connective tissue adhesions (3, 5). Proposed surgical therapies include Z-plasty of the quadriceps muscles (4), quadricepsplasty using silastic sheeting (7) or ophthalmic Gelfilm (8), sliding myoplasty (3, 5), excision of the vastus intermedius (3, 5), partial quadriceps myotomy (2), release of stifle extensor muscles (sartorius and tensor fasciae latae) (4), stifle arthodesis (3, 5), and limb amputation (3, 5). Conservative treatment using passive physiotherapy is not successful (1).

Recently, a dynamic flexion apparatus was described for the successful management of quadriceps contracture in a dog (9). The dynamic flexion apparatus was used to prevent recurrence of quadriceps contracture by lengthening the quadriceps muscles and encouraging early and active use of the affected leg. This report formed the basis of treatment in the present case and supports the use of a dynamic flexion apparatus in the management of quadriceps contracture in both cats and dogs. The dynamic flexion apparatus employed the proximal and the distal external fixateur constructs connected by elastic bands to allow flexion of the stifle. The design differed between the two cases with the method of proximal fixation and due to the fact that tarsal hyperextension was not present in the current case. A type I external fixateur was applied to the pelvis in the present case in order to increase the resistance of bending forces acting on the half-pin in the ischiatic tuberosity as a result of tension from the elastic bands. After three weeks, the pelvic fixateur loosened, the non-threaded pins in the ilium, and it was subsequently removed. The strength of the construct could be improved by increasing the number of fixation pins in the pelvis and using positive profile half-pins. Traumatic, ipsilateral hip dislocation did not recur in the case presented, despite the use of a pelvic fixateur. The use of the proximal femur as an attachment site for the dynamic flexion apparatus (9) may be preferable to pelvic anchorage. However, previously placed femoral implants may prevent the use of a femoral component of the dynamic flexion apparatus.

Following surgical release of fibrous adhesions between the quadriceps muscles and fracture callus and intra-operative fatigue and stretching of the quadriceps muscles the range of stifle motion in the present case improved from 35° to 110°. The use of a dynamic flexion apparatus and passive physiotherapy improved the range of motion in the affected stifle to 130°. The cat maintained this range of motion and excellent function six months post-operatively.

In conclusion, biological repair of comminuted fractures in young animals may increase the risk of developing quadriceps contracture. Following surgical release of the quadriceps muscles and insertion of an autogenous fat graft, the use of a dynamic flexion apparatus and intensive physiotherapy program may resolve the clinical signs associated with quadriceps contracture and prevent its recurrence.

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REFERENCES


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