Healing of patellar fractures in two kittens

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Summary
Two kittens aged between four and five months were presented having sustained patellar fractures. In both cases, healing was subsequently documented radiographically; this has not been reported previously in the literature.

One kitten had bilateral patellar fractures—the symptomatic right stifle was treated with a pin and tension-band-wire which later failed, at which point partial patellectomy was performed. The fracture of the left patella was minimally displaced and was treated conservatively. A radiograph of the left patella taken eleven months after initial presentation showed complete healing of the fracture. The second case was treated surgically with a circumferential wire; healing of the fracture was demonstrated radiographically at twelve weeks postoperatively. Radiographic images taken five weeks postoperatively had shown some narrowing of the fracture gap. These two cases demonstrate that bony union of patellar fractures can be documented, given a long enough duration of radiographic follow-up; circumferential wire was an effective treatment in a displaced fracture, and conservative treatment resulted in complete healing of a minimally displaced fracture.

Introduction
Patellar fractures in cats are uncommon and the aetiopathogenesis is uncertain. The treatment of these fractures is controversial and there are few cases in the literature which have been reported with adequate follow-up from which to draw conclusions on the most appropriate form of treatment. In a review of fifty-two patellar fractures, there are not any other documented cases of patellar fractures with radiographic evidence of healing reported in the literature.

The purpose of this report is to present two cases of patellar fractures in skeletally immature cats which have radiographically documented evidence of fracture union.

Case 1
A sixteen-week-old female entire Domestic Shorthaired cat weighing 1.2 kg was presented with the complaint of acute onset right pelvic limb lameness of 24 hours duration. There was a history of mild intermittent lameness of this limb but no history of trauma. On gait observation a grade 6/10 right pelvic limb lameness was noted. On orthopaedic examination, there were signs of pain on palpation of the right stifle, particularly in the region of the patella. There was no left pelvic limb lameness, and physical examination was otherwise unremarkable.

A mediolateral radiograph of the right stifle showed a complete transverse, markedly displaced fracture. The patella appeared sclerotic and the ends of the two fragments at the fracture line were rounded; this appearance is not consistent with an acute fracture (Fig. 1A). A mediolateral radiograph of the left stifle showed a complete transverse, minimally displaced fracture of the left patella (Fig. 1B).

The right patellar fracture was treated surgically. The cat was pre-medicated with acetalpromazinea (2 mg/ml injection) and methadoneb (10 mg/ml injection). General anaesthesia was induced with propofolc and maintained with isofluraneived in 100% oxygen. The fracture was reduced and reduced maintained with a pin and tension band technique. The left patellar fracture was treated conservatively. Following surgery the cat was discharged to the owner with instructions to provide cage rest. At the four-week follow-up examination, radiographic images taken of the right stifle showed that the pin had migrated from the distal fragment of the patella and the fragments had displaced. The implants were subsequently removed and a proximal partial patellectomy was performed.
Ten months following the initial diagnosis of bilateral patellar fractures, the cat was re-examined. It was considered to be sound on the right pelvic limb with an intermittent lameness of the left pelvic limb. A left grade 2/4 medial patellar luxation and a right grade 1/4 medial patellar luxation were found on physical examination. Radiographs taken eleven months following the initial diagnosis of bilateral patellar fractures showed signs of complete bony union of the left patellar fracture (Fig. 2).

According to the owner when telephone follow-up was performed three years later, the cat did not have any signs of pain or lameness.

Case 2

An eighteen-week-old male entire Domestic Shorthaired cat weighing 2.6 kg was presented with the complaint of left pelvic limb lameness. The onset was acute and there were no concurrent injuries; trauma had not been observed. On observation there was a non-weight-bearing lameness of the left pelvic limb. On examination, signs of stifle pain were not marked and no abnormalities were evident on palpation and manipulation of the stifle or patella.

A mediolateral radiograph of the left stifle showed signs of a mildly displaced complete transverse fracture of the patella (Fig. 3A). A mediolateral radiographic image taken of the right stifle did not show any abnormalities (Fig. 3B). The fracture of the left patella was treated surgically with a circumferential wire of 0.6 mm diameter, as described by Harari et al. (2). The cat was pre-medicat with acetalpromazine (2 mg/ml injection) and buprenorphine (0.3 mg/ml) General anaesthesia was induced with propofol and maintained with isoflurane in 100% oxygen. Further analgesia was provided by bupivicaine (0.5%) administered by epidural injection and intra-articularly together with meloxicam (0.5 mg/ml os) for seven days postoperatively. Postoperative radiographs showed a reduced distance between the fracture fragments, but there was still some displacement evident (Fig. 3C). After surgery, the cat was strictly cage-rested; after two weeks controlled exercise was started with walks around the house and garden on a lead and harness.

Radiographs taken five weeks postoperatively showed some evidence of healing (Fig. 4). Radiographs taken twelve weeks postoperatively showed complete healing of the fracture (Fig. 5). At this stage the cat was allowed out around the house for one week, and then allowed outside as normal thereafter. Two years following surgery, this cat was reported to have full function of both pelvic limbs with no lameness as reported by E-mail correspondence with the owner.

Discussion

In this report, two kittens aged between four and five months are presented, both of which had sustained patellar fractures that subsequently healed.

Patellar fractures in cats are uncommon. An incidence for patellar fracture of 0.1% to 0.25% of all bone fractures in cats and dogs has been reported (2). The most common type of fracture is a transverse fracture with variable displacement of the proximal and distal fragments (2). The majority of fractures occur without any history of trauma and occur at the level of the mid to proximal third of the patella (3, 4).

Patellar fractures in cats have previously been termed ‘bipartite’ and ‘tripartite’ pa-
tellae. In some veterinary texts they are described as a developmental anomaly of ossification and are usually considered to be asymptomatic in cats and dogs. The pathogenesis has been proposed to be due to poor vascularity in the mid-portion of the patella (5). There is now evidence that the so called 'bipartite' and 'tripartite' patellae are non-unions or chronic non-displaced patellar fractures. Radiographs have been seen of several cats with normal patellae, that then subsequently fracture and form non-unions; these cases would previously have been defined as having bipartite patellae (6). Transverse patellar fractures in cats have been hypothesized to be stress fractures. Stress fractures are the result of prolonged repetitive loading of a bone; the mean age of cats with apparent stress fractures of the patella was found to be two years and four months (1, 7). The cats reported herein were between four to five months of age and therefore would perhaps be considered to be too young to have stress fractures, although some of the characteristics of stress fractures such as sclerosis and pre-existing lameness were seen in case 1. Stress fractures in skeletally immature humans are uncommon, but in one case series of stress fractures the youngest child affected was two-years-old; this series included a transverse stress fracture of the patella in a seven-year-old boy (8).

Without having radiographs of the patellae of these two kittens prior to their presentation with lameness it is not possible to know if the radiolucent lines in the patellae were pre-existing, but this is entirely feasible in the kitten that presented with bilateral lesions. Certainly there is radiographic evidence of the patellae of older cats having a normal appearance prior to presentation with either a non-displaced radiolucent line or a displaced fracture, and the non-displaced fracture is not always associated with lameness (1). Incomplete ossification, non-displaced fractures or fissure fractures are well recognised in specific bones in dogs such as the humerus (incomplete ossification of the humeral condyle), the radiocarpal bone

Fig. 3 A) Lateral radiograph of left stifle of case 2 showing complete mildly displaced fracture of the patella. B) Lateral radiograph of right stifle of case 2 taken at the same time as the radiograph in Figure 3A. C) Postoperative lateral radiograph of the left stifle of case 2 showing the position of the circumferential wire and mild displacement of the two fracture fragments.

Fig. 4 A) Lateral and B) cranio-caudal radiographs of the left stifle of case 2 taken five weeks post-operatively; some narrowing of the fracture gap can be seen.
and the anconeal process (9–14). Further information is needed before it can be determined if the fractures seen in these kittens reported herein are analogous to any of the reported conditions in dogs.

The most common type of patellar fracture in skeletally immature humans is a sleeve fracture in which a small fragment of bone is avulsed from the patella (most commonly the apex), together with an extensive sleeve of cartilage, periosteum and retinaculum (15). The fragment is often so small as to be missed on radiographs, and so it would seem that the fractures that are presented here in kittens (transverse fractures approximately one-third of the length of the patella from the proximal pole) are of a different type (16). However in young cats, the soft tissue surrounding the patella may still be intact in minimally displaced fractures, and this may result in maintenance of vascularity and stability and hence an increased chance of healing.

Treatment options described for patellar fractures in cats include conservative treatment, or surgical internal fixation of transverse patellar fractures using a circumferential wire or a pin and tension band wire, and partial patellectomy (2, 3, 5, 17).

Surgical treatment of patellar fractures in cats with a pin and tension band wire has been found to have a high rate of complication; with the majority of cases (86%) sustaining further fractures and fragment displacement (1). This is consistent with the outcome of case 1 in our report, in which fixation failure occurred.

In a biomechanical study on human knees, treatment with circumferential wire has been reported to be an inferior technique compared to pin and tension band wiring in terms of rigidity of fixation of the fracture fragments (18). However the patellar fractures seen in cats are very different in both size and pathogenesis to human patellar fractures. The advantage of circumferential wiring is that it does not require implants to be placed within the patella bone, which risks causing iatrogenic fracture of a sclerotic bone which is usually brittle and contains multiple pre-existing microfractures and fissures (1, 7).

Partial patellectomy has been described for treatment of patellar fractures in cats as either first line treatment or revision surgery when other techniques have failed (1–3, 19–21). Partial patellectomy may be considered a salvage procedure to relieve pain. The patella functions to increase the mechanical advantage of the quadriceps muscles by increasing the lever arm (18). It is possible that removal of large fragments of the patella alter the biomechanics of the quadriceps mechanism, leading to suboptimal quadriceps function and persistent lameness (1). Complete patellectomy in the cat has been shown to result in poor functional outcome, with persistent lameness and quadriceps atrophy, and is considered to be contraindicated (22).

In non-displaced patellar fractures treated conservatively, a functional non-union may form or complete healing can occur as in the case reported herein (1, 3). If fragment displacement is not too severe and the pain can be managed, then it would seem an appropriate first-line treatment before performing partial patellectomy. With limited evidence it is not possible to define a maximum distance between fragments which may be successfully treated conservatively, however one recommendation was that non-displaced, minimally displaced, or mildly displaced patellar stress fractures with a fracture gap of up to one-half of the whole patellar length were candidates for conservative management, provided that signs of pain are mild or absent (1).

There are similarities between the cases reported here and the case reported by Palierne et al. in which a 14-week-old cat was presented with unilateral pelvic limb lameness and evidence of bilateral pain on palpation of the patellae (21). Radiographically, there was a moderately displaced transverse patellar fracture of the lame limb, and non-displaced fragmentation of the patella of the non-lame limb. This cat was treated with bilateral partial patellectomy and it was thought that the fragmented patellae were a manifestation of osteochondrosis based on histopathological findings. Partial patellectomy was performed on the non-displaced fragmented patella due to signs of pain on palpation of this patella and the perceived risk of secondary fracture (21). Osteochondrosis lesions do not usually spontaneously heal. It is very difficult to diagnose osteochondrosis as a causal factor in a fracture based on histopathology if the sample is taken some time after the lesion initially occurred. Palierne et al. described that the tissue interposed between the fragments filled with persistent hyaline cartilage, with the cartilage at the centre of the lesion initially replaced by an area of necrosis. If blood supply to a fracture site is compromised, hyaline cartilage will form and necrosis can occur (23), hence the fracture gap in non-union frac-

Fig. 5  A) Lateral and B) cranio-caudal radiographs of left stifle of case 2 taken 12 weeks postoperatively which show complete healing of the fracture line.
tasures contains fibrous tissue, fibrocartilage and hyaline cartilage (23, 24). Histological analysis of the fracture gap may thereby not give a definitive differentiation between initiating causes of the fracture.

Some older reports suggested that the prognosis for patellar fractures in the cat was good regardless of the method of treatment used (3, 17, 22). However, in none of those cases was radiographic evidence of healing ever documented, and in a survey of 52 patellar stress fractures, the prognosis for return to full function was found to be guarded with over 50% of cases having persistent intermittent lameness at follow-up. Ninety-eight percent of cases did not heal but formed functional non-unions (1).

The healing process that occurs following sesamoid bone fracture differs from that which typically follows long-bone fracture; sesamoid fractures stabilise by production of fibrous callous and very little ossified callous (3). The healing time for surgically treated patellar fractures in mature humans has been reported to be 10 weeks; there is no published information on the healing time of the patella or other sesamoid fractures in small animals (25). In four- to five-month-old kittens with long-bone fractures, radiographic evidence of healing should be apparent by three to four weeks and complete by six weeks. In case 1, healing was documented in radiographs taken 11 months following initial presentation; no radiographs had been taken in the intervening period. In case 2, there was some evidence of healing in radiographs taken five weeks postoperatively, but not to the degree that would be expected of a fracture in a young cat; complete healing was documented at 12 weeks. In the one case of a healed patellar fracture reported previously in the literature, the cat had radio-

graphs taken 34 months postoperatively. From these three cases, it is not possible to give a predicted healing time for patellar fractures in cats, but it may be suggested that healing may be delayed. It is therefore recommended to evaluate these fractures radiographically at regular intervals until healing is documented.

From these two cases no firm conclusions can be made except to report that circumferential wiring was effective treatment for a mildly displaced fracture, and conservative treatment was successful in achieving healing of a minimally displaced asymptomatic fracture in two kittens.

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Conflict of interest
None declared.

References