Patellar ligament rupture in a cat treated with autologous fascia lata graft augmentation

Stefano Manca, Philip Georg Witte

SUMMARY
A five-year-old male domestic shorthair cat has been referred with a two-week history of lameness affecting the right hind limb. Gait assessment revealed an involuntary flexion of the stifle during the stance phase with excessive hip extension and stifle flexion in the terminal phase of the stride. Physical examination and radiographs have been performed and were consistent with patellar ligament rupture. Surgical correction consisted of primary tendon tenorrhaphy, circumpatellar suture and fascia lata graft augmentation. Eight months following surgery, validated owner questionnaire confirmed an excellent outcome.

BACKGROUND
Patellar ligament rupture (PLR) is an infrequent injury and is rarely reported in small animal medicine. In the cat and the dog, PLR is most commonly associated with trauma (with a relatively high frequency of iatrogenic trauma during stifle surgery). It is usually theorised to occur following a vigorous contraction of quadriceps femoris muscles simultaneous to a forced stifle joint flexion. In the skeletally immature dog, similarly applied quadriceps tension is theorised to be the cause of tibial tuberosity avulsion. Spontaneous bilateral PLR associated with fluoroquinolone treatment has been reported in a dog.

Patients affected by PLR present with severe hind limb lameness. Physical examination reveals pain and stifle swelling, particularly on the cranial aspect of the joint. PLR results in passive flexion of the stifle during the stance phase of the gait cycle caused by the failure of the quadriceps mechanism to maintain extension. PLR is a rare condition in the cat. To date, the published literature consists of one case series containing seven cats with PLR.

CASE PRESENTATION
A five-year-old male domestic shorthair cat, weighing 5 kg, has been referred with a two-week history of lameness affecting the right hind limb. Prior management had involved meloxicam (0.05 mg/kg, Metacam, Boehringer Ingelheim) orally and room rest during the previous 14 days, but no clinical improvement had been seen. On presentation, the patient was bright, alert and responsive with vital functions within the normal limits. Gait analysis revealed severe right hind limb lameness characterised by involuntary flexion of the stifle during the stance phase with excessive hip extension and stifle flexion in the terminal phase of the stride (figure 1). Stifle joint palpation revealed abundant swelling. Severe discomfort was elicited with stifle manipulation, while the rest of the orthopaedic examination was unremarkable.

INVESTIGATIONS
Medetomidine (5 µg/kg, intramuscularly, Domitor, Vetquino, UK) and methadone (0.2 mg/kg, intramuscularly, Comfortan, Dechra, UK) were administered as premedication. General anaesthesia was induced with alfaxalone (3 mg/kg, intravenous, Alfaxon, Jurox) and maintained by isoflurane (IsoFlo, Zoetis) delivered in 100% oxygen. Intravenous fluid therapy was provided with compound sodium lactate (5 ml/kg, Vetivex11, Dechra). An epidural injection of bupivacaine (1 mg/kg, Marcain Polyamp 0.5%, Aspen) combined with preservative-free morphine sulfate (0.1 mg/kg, morphine sulfate, Macarthys) was administered preoperatively. Cefuroxime (20 mg/kg, Zinacef, GSK) was administered intravenously 30 min before the first incision.

Initial mediolateral radiographs of the right tibia, stifle and distal femur revealed severe thickening of the patellar ligament (PL), with a small discrete mineral opacity centrally within the PL shadow. Severe soft tissue swelling surrounding the right stifle obscured an assessment of the fat pad. Mediolateral views were acquired in neutral and flexed positions (figure 2A,B). The distance between the distal pole of the patella and the tibial tuberosity increased significantly with flexion of the stifle, which was considered pathognomonic for PL lengthening (grade 2 sprain) or complete rupture (grade 3 sprain). Patella alta was also visible in the caudocranial projection of the right stifle (figure 3A,B).

DIFFERENTIAL DIAGNOSIS
PLR of traumatic aetiology is most likely. Predisposing pathologies such as neoplasia and infection could not be excluded from plain radiography alone.

TREATMENT
Under the same general anaesthesia, the patient was positioned in dorsal recumbency and the right hind limb clipped and prepared with chlorhexidine (Vetasept 4%, Animakare). An iodine impregnated incision drape (Ioban, 3M) was applied. A craniolateral incision was made, extending from 2 cm distal to the greater trochanter to the distal extent of the tibial tuberosity. Direct visualisation confirmed the...
rupture of the PL with a full-thickness defect apparent approxi-
mately in the proximo-distal centre. A lateral parapatellar
arthrotomy was performed. The cranial and the caudal cruciate
ligaments were visualised and appeared unremarkable. It was
not possible to identify the intra-articular mineralisation noted
radiographically (figure 4A). Two longitudinal parallel incisions
were made in the aponeurosis of the fascia lata extending from
the level of the distal tensor fascia lata muscle to 1 cm distal to
the patella to create a fascia lata graft approximately 1.5 cm wide
and 4 cm long with a distal base (figure 4B). A bone tunnel was
drilled medial to lateral in the proximal tibial tuberosity using a
2.5 mm drill. A single loop 50-pound breaking strength nylon
leader line (Cranial cruciate ligament lateral suture system, VI,
Sheffield) was passed lateral to medial through the tibial tuber-
osity bone tunnel. The leader line was passed proximally, parallel
to the medial aspect of the PL, and purchased it twice before
passing medial to lateral through the quadriceps muscles just
proximal to the patella. The lateral aspect of the PL was simi-
larly purchased twice (two ‘bites’ of parapatellar tissue), and a
surgeon’s knot was used to secure the suture on the lateral side.
Before placing the second throw of the surgeon’s knot, tension
was applied to correctly locate the patella in the trochlear groove
(figure 4C,D). Disrupted tissue was sparingly debrided from the
PL at both torn ends. Polydioxanone (PDS, Ethicon) 2 metric
was used to reappose the torn ends of the PL in two locking loop
sutures. The fascia lata graft was passed through the quadriceps
eorum from lateral to medial proximal to the patella and placed
over the PL extending to the cranial fascia of the cranial tibial
muscle. The tip of the graft was secured adjacent to the tibial

Figure 1  Images selected from footage of the cat with right PLR
walking in a consultation room. Note the exacerbation of the flexion
of the right stifle due to the deficiency of the quadriceps mechanism as a
result of PLR. PLR, patellar ligament rupture.

Figure 2  Mediolateral plain radiographic projections of the right stifle
in neutral position (A) and flexion (B); note patella alta, in addition to
an increased distance between the patella and the tibial tuberosity
confirming PLR. PLR, patellar ligament rupture.

Figure 3  Craniocaudal views of the right (A) and left (B) stifles. Note
the proximal location of the patella on the right, consistent with patella
alta secondary to PLR. PLR, patellar ligament rupture.
Photographs taken during surgery from the lateral aspect with proximal on the left in figure part A and from cranial aspect with the stifle flexed with proximal at the top in figure parts B–F. (A) The patella is reflected medially to expose the retropatellar surface and the caudal aspect of the patellar ligament. The yellow arrow indicates an area of discoloration of the patellar ligament at which a palpable thinning of the tissue demarked the rupture. (B) The white arrow indicates the patella, the yellow arrow indicates the PLR defect, the red arrow indicates the fascia lata graft, the blue arrow indicates the tibial tuberosity. (C) Circumpatellar suture placement; (D) PL defect following circumpatellar loop placement; (E) cranial aspect of the stifle following passage of the fascia lata graft from lateral to medial (proximal to the patella) and initial securing to fascia overlying the medial aspect of the tibial tuberosity; (F) cranial aspect of the stifle following further securing of the fascia lata graft to parapatellar fascia and joint capsule. Note also cruciate suture used to reduce dead space at the graft donor site. PLR, patellar ligament rupture.

Mediolateral radiographic projections of the stifle in flexed (A) and neutral (B) position following surgery to address PLR. Note that the area of mineralisation within the joint remained in situ. A bone tunnel used to secure nylon leader line encircling the patella is apparent caudal to the tibial tuberosity. Subjectively patella baja is present, particularly apparent in the flexed view. The distance between the tibial tuberosity and the patella remains unaltered in a neutral and flexed position indicating a stiff PL repair. PL, patellar ligament; PLR, patellar ligament rupture.

Outcome and follow-up

Postoperative mediolateral radiographs in neutral and flexed position were acquired to assess the position of the patella (figure 5A,B). There was no change in the length of the PL between natural and flexed views. Subjectively, patella baja was apparent. The patient was hospitalised for 24 hours after the operation. Methadone (0.3 mg/kg, Comfortan, Dechra) was administered intravenously every four hours for three consecutive times then swapped to buprenorphine (0.02 mg/kg, Vetergesic, Ceva) every eight hours intravenously for two consecutive times. A continuous rate infusion of ketamine (3 µg/kg/min, Anesketin, Dechra) was started four hours following surgery to address discomfort considered to be present due to the cat’s behaviour in kennel and discontinued after 12 hours. The patient was discharged from the hospital with meloxicam (0.05 mg/kg, orally, Metacam, Boehringer Ingelheim) once daily for the following 14 days.

Four weeks following surgery, the cat was reassessed, and no lameness in the operated limb was observed. Gait examination at that stage in the consulting room revealed no lameness in the right hind limb. Furthermore, there was no palpable stifle swelling although periarticular thickening was apparent. The patella was palpable and was subjectively considered to be approximately located in the region of the trochlear groove. There was no resentment to stifle manipulation, and the range of motion was within the normal limits.

Because clinical function and findings on examination were favourable, the owner declined further radiographic follow-up.

Medium-term follow-up was achieved with a validated owner-completed questionnaire at eight months following surgery (Feline Musculoskeletal Pain Index (FMPI), North Carolina State University). FMPI involves owner assessment of chronic pain in their cats and was originally created to assess the response of treatment in cats with osteoarthritis. The most recent version of FMPI (2015) consists of 17 items pertaining to mobility and ability to perform daily activities including jumping, running, playing and resting. On a scale from 0 to 72, the FMPI score for this patient eight months following surgery was 0, suggesting a lack of pain or physical impairments.

OUTCOME AND FOLLOW-UP

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Tuberosity bone tunnel using a polydioxanone (PDS II, Ethicon, 2M) locking loop suture (figure 4E). Polydioxanone (PDS II, Ethicon, 2M) cruciate interrupted sutures were placed to secure the graft to the underlying tissue. Closure of the fascia lata defect was with a cruciate interrupted pattern using 2 metric polydioxanone (PDS II, Ethicon) (figure 4F). Skin closure was performed with two layers of simple continuous sutures.
DISCUSSION
This case report describes surgical management of a cat with PLR of two weeks’ duration in which direct fibre realignment and suturing was considered inadequate, so augmentation with fascia lata graft was performed.

Diagnosis of PLR in small animals relies mainly on physical examination and radiography. The largest case series regarding PLR in small animals was published by Das and others in which radiographic signs of patella alta were considered the most reliable to diagnose PLR in dogs.

As discussed in a recent editorial by Witte, surgical management of canine PLR can be divided into three steps: primary tenorrhaphy; circumpatellar or trans patellar augmentation (with synthetic or graft tissue); and temporary immobilisation of the stifte.

In a recent case series by Das and others, seven cats were treated for PLR. All cases received a sutured anastomosis (primary tenorrhaphy) of the ruptured ligament, with six of the repairs protected by a circumpatellar and/or transpatellar loop of suture. Three stifles were immobilised by transarticular external skeletal fixation (TA-ESF). Two stifles received a fascia lata graft augmentation. However, no clear algorithm for the selection of specific approaches was apparent. Biologically, primary tenorrhaphy, as a sole repair technique, is adequate in the presence of healthy ligament tissue with a good blood supply allowing direct healing of closely apposed torn ends. However, mechanically, this may be inferior since the linear arrangement of collagen fibres in the PL makes for limited resistance to longitudinal slipping of suture material. The presence of a gap during tendon/ligament healing is recognised to reduce the eventual tensile strength of the healed tissue. In this case, the necessity to debride disrupted ligament tissue might have resulted in greater tension on a primary tenorrhaphy. This was thought to increase the potential for gap formation following surgery. A circumpatellar nylon loop was placed to neutralise the force of quadriceps contraction and reduce the risk of gap formation.

The technique of fascia lata graft augmentation for PLR in dogs and cats was published for the first time by Culvenor. Where a defect in the PL exists, as in the current case, the fascia lata graft serves two purposes: first, provision of vascular tissue through which neovascularisation of adjacent traumatised PL may occur (ie, biological) and second, the tissue itself may undergo remodelling (ligamentisation) and at least partially restore lost native PL tissue (ie, mechanical). It is unlikely that a fascia lata graft anchored to a tibial bone tunnel and secured to the surrounding soft tissues provides superior mechanical protection to the early healing PL than a circumpatellar nylon loop.

Joint immobilisation is performed to reduce the strain on the healing ligament. However, articular immobilisation has a deleterious effect on the stifle. Reported changes include reduced synovial fluid production, reduced cartilage stiffness and increased thickness, and reduced stifle range of motion. It also leads to cartilage fibrillation, cleft formation, intra-articular adhesions, periarticular contractures and the development of degenerative joint disease in normal and injured joints. Joint immobilisation also leads to loss of muscle mass and bone mineral content and density. A retrospective case series documenting 145 cats with TA-ESF demonstrated a complication rate of 19 per cent. Superficial pin tract infection (SPTI) and implant failure accounted for 45 per cent and 41 per cent of all frame associated complications, respectively. While SPTI is of minimal concern, typically resolving with symptomatic therapy or frame removal, implant failure may necessitate further surgery and may be the source of significant morbidity. Given a relatively high complication rate with TA-ESF in cats, the authors of this case report suggest that joint immobilisation should be reserved for cases in which it is unavoidable.

Decision making regarding surgical intervention for PLR has been reported to be influenced by whether the rupture is acute or chronic. However, in small animals orthopaedics, it is difficult to find a true definition of acute or chronic tendon rupture. In this case, the injury was technically not chronic as defined by how did Anakwenze and others define it (injury more than four weeks old). Loss of normal architecture at the level of the rupture is likely to occur within a matter of weeks as haematoma is remodelled to disorganised fibrous tissue. At what stage direct apposition of torn ends might be expected to have a poorer prognosis for healing compared with apposition following debridement of torn ends is not clear. More slowly, remodelling of the remainder of the ligament (tissue that was unaffected by the initial trauma and ensuing inflammatory process) would be expected to occur, as a result of an altered strain environment. In such a situation, the surgeon should consider replacement of PL tissue to be of greater importance, since primary tenorrhaphy may be less likely to provide an acceptable strain resistance. Perhaps, it is the contracture of the associated muscles, acting to increase a gap within the tendon or ligament, which causes the greatest difficulty to the surgeon trying to decide whether fibre apposition alone is sufficient or not. An algorithm to help surgeons to decide when to augment primary tenorrhaphy with a circumpatellar suture or fascia lata autograft and when to decide to add temporary joint immobilisation does not exist. The authors would argue that primary tenorrhaphy alone is unlikely to be successful in most cases of PLR, and in 6/7 reported cases of feline PLR, the surgeons agreed with this position by placing circumpatellar suture. This opinion is not supported by evidence. In fact, in a single case, primary tenorrhaphy was performed as a sole method of repair of PLR in a cat, and the outcome was favourable.

In the current case, it was decided that fibre apposition (primary tenorrhaphy) and protection of the repair with a circumpatellar suture were appropriate, and given a small defect following primary tenorrhaphy, additional augmentation with fascia lata graft was also considered appropriate. Given minimal morbidity and some potential benefits in terms of articular stabilisation and tendinous defect restoration, the authors would argue that this technique should be considered for cases of PLR more than 10–14 days of duration.

Learning points
- Patellar ligament rupture (PLR) is an infrequent injury in small animal patients.
- Diagnosis of patellar ligament rupture in this cat was with physical examination and radiography.
- Surgical approach including patellar ligament primary tenorrhaphy and augmentation with circumpatellar suture and fascia lata autograft resulted in an excellent outcome.
- Fascia lata graft augmentation might be beneficial in terms of articular stabilisation and tendinous defect restoration.

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REFERENCES

1. Das S, Thorne R, Langley-Hobbs SJ, et al. Patellar ligament rupture in the cat: repair methods and patient outcomes in seven cases. J Feline Med Surg 2015;17:348–52.
2. Shipov A, Shahar R, Joseph R, et al. Successful management of bilateral Patellar tendon rupture in a dog. Vet Comp Orthop Traumatol 2008;21:181–4.
3. Pratt JN. Avulsion of the tibial tuberosity with separation of the proximal tibial physis in seven dogs. Vet Rec 2001;149:352–6.
4. Cabassu JP, Ivanoff S, Haroutunian G, et al. Rupture bilatérale des ligaments patellaires Chez un Chien pendant un traitement l’enrofloxacine. Traitement Revue Méd Vét 2001;152:523–30.
5. Comparative pain research laboratory, North Carolina state University, feline pain musculoskeletal index, 2015. Available: https://journals.plos.org/plosone/article/file/?type=supplementary&id=info:doi/10.1371/journal.pone.0131839.s001 [Accessed 10 Sep 2019].
6. Das S, Thorne R, Lorenz ND, et al. Patellar ligament rupture in the dog: repair methods and patient outcomes in 43 cases. Vet Rec 2014;175:370.
7. Witte P. Treating canine Patellar ligament rupture. Vet Rec 2014;175:368–9.
8. Gelberman RH, Boyer MI, Brodt MD, et al. The effect of gap formation at the repair site on the strength and excursion of intrasynovial flexor tendons. An experimental study on the early stages of tendon-healing in dogs. J Bone Joint Surg Am 1999;81:975–82.
9. Culvenor JA. Fascia lata flap to reinforce repair of patella ligament injuries in the dog and cat. J Small Anim Pract 1988;29:559–63.
10. Jurvelin J, Kvivanta I, Tammi M, et al. Softening of canine articular cartilage after immobilization of the knee joint. Clin Orthop Relat Res 1986;207:246–52.
11. Schwartz ER. Animal models: a means to study the pathogenesis of osteoarthritis. J Rheumatol 1987;14 Spec No:101–3.
12. Beever L, Giles K, Meeson R. Postoperative complications associated with external skeletal fixators in cats. J Feline Med Surg 2017;19:727–36.
13. Anakwenze DA, Baldwin K, Abboud JA. Distal biceps tendon repair: an analysis of timing of surgery on outcomes. J Athl Train 2013;48:9–11.