Ilial crest bone graft transposition as treatment for fracture of the medial femoral trochlear ridge in a dog

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Bone graft, fracture, complication, trochlear, patella

Summary
This is a report of a fracture of the medial trochlear ridge of the distal femur occurring as a major complication after surgery for medial patellar luxation. To address the complication, a non-vascularized iliac bone graft was collected and fixated with two positional screws to the trochlea. An external skeletal fixator was placed to prevent motion of the stifle joint during the healing period and to reduce the risk for fragment dislodgment. One year after the graft was placed the dog’s function was satisfactory. This case report indicates that a non-vascularized iliac bone graft provides an alternative for management of fractures of the medial ridge of the distal femur.

Introduction
Medial patellar luxation is a common orthopaedic condition in dogs (1–4). The surgical procedures that are most commonly recommended to correct medial patellar luxation in dogs are a combination of lateral transposition of the tibial crest, femoral trochlear groove deepening, and soft tissue reconstruction (4–7). Reported complications of surgical repair of medial patellar luxation are relaxation of the patella, infection, implant failure, avulsion of the tibial tuberosity, over-correction leading to lateral patellar luxation, and fracture of the lateral trochlear ridge after trochleoplasty (8, 9). One study of 109 dogs found the overall frequency of complications after corrective surgery of medial patellar luxation to be 18% and patellar relaxation accounted for 65% of the complications (9).

Fractures of the trochlear ridge are rare in the dog and usually associated with complex fractures of the femoral condyles (10). Isolated fracture of the medial trochlear ridge as a major complication after trochleoplasty, treated with a non-vascular cortical bone graft has not, to the authors’ knowledge, been reported.

Cancellous bone autograft is commonly used to promote healing in arthrodesis or in fractures with major bone loss (11). However, it lacks structural strength precluding its use as a structural graft (12). Autogenous cortical bone grafts have been employed as a treatment option for the correction of canine mandibular deficiencies (13, 14). Also non-vascular iliac bone graft has been used for mandibular reconstruction after removal of an intra-oral tumour in human surgery (15). When bone loss prevents anatomical reduction and fixation of intra-articular fractures, a cortical bone graft can provide structural support and allow the joint to be restored (15). This report details the management of a dog with multiple complications following surgical repair of medial patellar luxation, where a fracture of the medial trochlear ridge following trochlear block recession was treated with a non-vascular iliac crest bone autograft.

Case report
A nine-month-old male French Bulldog, weighing 13.6 kg, was presented for evaluation of an intermittent left hindlimb lameness of one month duration. The owner had observed that the left patella appeared to be luxating and the lameness was gradually deteriorating. At the initial examination, there were no visible signs of lameness, but the left stifle had a grade two out of four medial patellar luxation. Physical examination was otherwise unremarkable. Since the owner had observed a gradual deterioration in the patient’s gait, surgery was recommended to correct the medial patellar luxation.

Surgical technique
A crano-lateral approach was made to the left stifle joint. A lateral arthrotomy was
The distal femur was found to have a varus angulation. The quadriceps-patella-tibial tuberosity axis was medially malaligned. The articular cartilage on the patella was eroded laterally, but no further cartilage damage could be found in the joint. The trochlear groove was assessed to be of normal depth distally while the proximal aspect of the groove was moderately shallow; therefore a trochlear sulcoplasty was deemed to be unnecessary. A tibial tuberosity transposition was performed with a fine-toothed handheld saw, and the tuberosity was transposed approximately 5 mm laterally and stabilized with two 1.0 mm Kirschner wires and a 0.8 mm cerclage wire placed as a figure-of-eight tension band. The arthrotomy was imbricated with 2 metric polydioxanone suture in a vest-over-pants pattern. The subcutaneous layer and skin were closed routinely. The patella tracked normally in the femoral trochlea after surgery. There was a slight lateral deviation of the patellar ligament in full extension and a small medial deviation in full flexion, but a patellar luxation could not be provoked. Postoperative treatment consisted of application of a full-limb bandage for 24 hours and the administration of methadone (0.3 mg/kg, every four hours as needed for the first 24 hours) and carprofen (2 mg/kg BID for 14 days). The day after surgery the dog was toe-touching on the left hindlimb, and was sent home. Owners were instructed to enforce strict rest and to not allow high impact activity at any time during the first four weeks post-surgery.

Six days post-surgery the dog was re-evaluated by the centre’s physiotherapist. It had a left hindlimb lameness with toe-touching at the trot. There was mild muscle atrophy of the left hindlimb compared to the contra lateral limb. The stifle joint range-of-motion was normal in flexion and extension and the patella tracked normally in the femoral trochlear groove. The owners were requested to walk the dog in a water treadmill once a week, to do passive range-of-motion exercises at home, and to increase the number of walks gradually. One month post-surgery the owners reported that the dog had escaped earlier that day to chase a cat and upon its return they could palpate luxation of the left patella. The dog was admitted to the hospital and on examination a diagnosis of luxation of the left patella was confirmed. Radiographs of the hindlimbs revealed medial displacement of the left patella with moderate effusion of the left stifle joint. The position of implants was unchanged and showed no signs of failure.

**First revision surgery**

A cranio-lateral approach into the old surgical scar of the left stifle joint was made once again. Inspection of the joint revealed a fractured medial trochlear ridge with a grade 3 out of 4 medial luxation of the patella. The whole medial ridge was fractured and was displaced medially in the joint. The medial ridge was determined to be too thin to be reattached and the incision was closed temporarily. A decision was made to collect a bone graft from the iliac spine. After re-preparation for surgery, the iliac spine was exposed and an oscillating saw was used to perform an osteotomy of the dorsal 1.5 cm of the iliac spine from the ilium crest and caudally. The cortical bone graft was contoured using the fractured post-surgery osteotomies were made using a fine-toothed hand-held saw and the block recession was performed with 6 mm and 8 mm osteotomes. The revised medial ridge was only 3–4 mm wide and therefore weaker than intended, but a shallower trochlea would have resulted in a suboptimal coverage of the patella. No further transposition of the tibial tubercle was necessary since the quadriceps-patella-patellar ligament axis was assessed as being properly aligned. The joint was closed using a similar technique as the first surgical procedure. The patella was tracking normally in the femoral trochlea and 7.5 mg of bupivacaine was injected into the joint. Postoperative treatment and aftercare instructions to owners were the same as after the first surgery. The dog was sent home the day after surgery. One week post-surgery the dog was once again presented with a reluxating patella. Palpation of the stifle joint did not elicit any signs of pain and severity of the lameness was unchanged. A second revision surgery was recommended.

**Second revision surgery**

A cranio-lateral approach into the old surgical scar of the left stifle joint was made once again. Inspection of the joint revealed a fractured medial trochlear ridge with a grade 3 out of 4 medial luxation of the patella. The whole medial ridge was fractured and was displaced medially in the joint. The medial ridge was determined to be too thin to be reattached and the incision was closed temporarily. A decision was made to collect a bone graft from the iliac spine. After re-preparation for surgery, the iliac spine was exposed and an oscillating saw was used to perform an osteotomy of the dorsal 1.5 cm of the iliac spine from the ilium crest and caudally. The cortical bone graft was contoured using the fractured post-surgery osteotomies were made using a fine-toothed hand-held saw and the block recession was performed with 6 mm and 8 mm osteotomes. The revised medial ridge was only 3–4 mm wide and therefore weaker than intended, but a shallower trochlea would have resulted in a suboptimal coverage of the patella. No further transposition of the tibial tubercle was necessary since the quadriceps-patella-patellar ligament axis was assessed as being properly aligned. The joint was closed using a similar technique as the first surgical procedure. The patella was tracking normally in the femoral trochlea and 7.5 mg of bupivacaine was injected into the joint. Postoperative treatment and aftercare instructions to owners were the same as after the first surgery. The dog was sent home the day after surgery. One week post-surgery the dog was once again presented with a reluxating patella. Palpation of the stifle joint did not elicit any signs of pain and severity of the lameness was unchanged. A second revision surgery was recommended.

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a Metadon, MetadonRecip: RecipAB, Solna, Sweden  
b Carprofen, Rimadyl: Orion Pharma Animal Health, Sollentuna, Sweden  
c Lambotte straight tip osteotomes: Aesculap, Danderyd, Sweden  
d Bupivacain, Marcin: AstraZeneca, Södertälje, Sweden  
e Dynonics oscillating saw: Smith & Nephew, Solna, Sweden
A full-limb padded bandage was applied post-surgery for 24 hours. The postoperative medications included methadone (0.3 mg/kg, every four hours as needed for the first 24 hours). A fentanyl patch^h^ (50 microgram) was applied and carprofen (2 mg/kg, BID for 14 days) was also prescribed. In addition, amoxicillin^i^ (10 mg/mg BID for 8 days postoperatively) was prescribed. The patient was sent home the day after surgery with the same instructions for postoperative care as previously. Ten days post-surgery the dog was presented to the centre’s physiotherapist with a toe-touching lameness of the left hindlimb. The external skeletal fixation was in place and showed no signs of failure. Physiotherapy was performed once a week and during this period the lameness gradually improved. Radiographs of the left stifle joint obtained three weeks post-surgery did not reveal any complications concerning the bone graft or external fixator. At six weeks postoperatively, follow-up examination revealed non-weight bearing lameness of the left hindlimb; the owners reported that the dog had stopped bearing weight on the limb two weeks earlier. Radiographs of the left stifle joint revealed extensive osteolysis around the pin holes. The graft appeared to be in place and there were no radiographic signs of osseous change around the screws (Figure 2). The external skeletal fixation was removed and the pins were sent for bacterial culture. Postoperative medication consisted of clindamycin^j^ (10 mg/kg BID) pending the bacterial culture. Aerobic culture was positive for *Staphylococcus pseudointermedius* and sensitivity test revealed resistance to clindamycin but sensitivity to amoxicillin with clavulanic acid. The antibiotic medications were subsequently changed to amoxicillin with clavulanic acid^k^ (11.5 mg/kg BID for six weeks). The dog was discharged to its owners with instructions of strict rest.

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**Figure 2** Lateral radiograph directly after removal of the external skeletal fixation. Well-defined radiolucent holes in the area of the previous pins are partly surrounded by a rim of sclerosis. Smoothly margined periosteal reaction especially around the most proximal hole. No detectable reaction around the remaining implants.

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**Figure 3** A) Craniocaudal and B) lateral radiographs of the stifle joint four weeks after removal of screws. There is a relatively well-defined concave radiolucent area in the region of the previous proximal screw. The area is cranially surrounded by partly angulating mineral opacities, which may represent periosteal reactions, graft remodelling, or a combination of both.

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^f^ Cortical screws: Smith&Nephew, Mölndal, Sweden  
^g^ IMEX Veterinary, Inc., Longview, TX, USA  
^h^ Fentanyl, Durogesic: Janssen-Cilag AB, Sollentuna, Sweden  
^i^ Amoxicillin, Vetrimoxin: Ceva Animal Health, Lund, Sweden  
^j^ Clindamycin, Clindabuc: Ceva Animal Health, Lund, Sweden  
^k^ Amoxicillin with clavulanic acid, Synulox: Orion Pharma Animal Health, Sollentuna, Sweden
examination one week after external skeletal fixation removal the dog was weight bearing at the walk but non-weight bearing while trotting. The dog continued regular physiotherapy and the lameness improved slowly.

**Outcome**

Upon follow-up examination at 16 weeks post-surgery, the owner reported there had been improvement in the lameness. On examination, grade 1 out of 5 hindlimb lameness was present. The patella was tracking normally within the femoral trochlea. A mild reduction in muscle mass of the left hindlimb in comparison to the contralateral limb was palpable. Radiographs showed signs of osteolysis around the implants in the iliac graft and the screws were subsequently removed and sent for culture. At removal, the screws were not loose. Since the procedure was minimally invasive, visual inspection of the joint or the graft was not performed. The dog was sent home with instructions to administer amoxicillin with clavulanic acid (11.5 mg/kg for three weeks). Subsequently the culture results were negative. Four weeks after removal of the screws, the dog was showing progressive improvement of the lameness and radiographs showed less osteolysis around the screw holes (Figure 3).

Four months after screw removal radiographs showed more homogenous periosteal reaction with reduction in size of the screw holes indicating further remodelling of the bone graft. The radiolucent area surrounding the proximal screw hole had the same appearance as in the previous radiographs (Figure 4).

At the 13-month post-surgery follow-up examination, no signs of lameness were apparent to the owner and the dog was allowed to exercise freely. All medications had been discontinued at five months post-surgery. At examination, no lameness could be observed at the walk and the dog was fully weight bearing in stance on both hindlimbs. The patella tracked normally within the femoral trochlea and only very mild muscle atrophy of the left hindlimb was noticeable. The stifle was palpably thickened without any signs of pain or discomfort on palpation.

**Discussion**

In this case report, we describe the use of a nonvascular iliac crest cortical bone graft to repair a fracture of the medial ridge of the femoral trochlea that developed as a complication after a trochlear block recession.

Trochleoplasty, to deepen the femoral trochlea, is often used to treat canine patellar luxation. The patellar depth and patellar articular contact with the recessed trochlea is considered to be significantly greater after trochlear block recession than with trochlear wedge recession (17). The trochlear block recession technique was chosen at the first revision surgery after it was found that the depth of the proximal trochlea was insufficient to offer adequate support for the patella. However due to the distal femoral varus, the result was a thin medial trochlear ridge. The reason for the medial trochlear ridge fracture was probably that it was inadequate to withstand the abaxial forces applied by the patella and quadriceps mechanism during normal weight bearing. If trochlear wedge recession had been performed instead of trochlear block recession, the base of the trochlear ridge would have been thicker and this complication may have been avoided. In this patient, a trochlear wedge recession was not chosen because it was deemed that this would not offer sufficient coverage of the patella at the proximal aspect of the trochlea. Other possible reasons for the fracture could have been external trauma to the medial trochlear ridge however there was no history to support this hypothesis. A similar complication was recently reported where the lateral trochlear ridge fractured after a trochlear block recession as treatment for medial patellar luxation. In this case, the difference was that the lateral ridge was thick enough to be reduced and fixed back in place (8).

However, in our case the fractured medial ridge was considered to be too thin for reattachment, therefore an iliac graft transposition was performed to create a more robust medial trochlear ridge. We found that it was relatively easy to access the iliac crest and the shape of the bone was deemed to be suitable for the purpose.

The availability of preoperative radiographs prior to the second revision surgery would have made the surgeon aware of the fracture allowing for a structured approach minimizing surgery time and postoperative complications. However preoperative radio-
graphs were not obtained prior to the second revision surgery because there was no history of trauma, or signs of pain or increased lameness that could lead to a clinical suspicion of an intra-articular fracture. There were also financial restraints by the owners.

An external skeletal fixation was placed to prevent stifle joint motion during the early healing period of the bone graft since this was a very active dog. However the use of the transarticular external skeletal fixation to immobilize the stifle joint can lead to chronically decreased stifle range-of-motion and contracture of the quadriceps muscle, and therefore it should be reserved for cases where it is deemed to be absolutely necessary. As was the experience in our case, a common complication associated with the use of the external skeletal fixation is pin tract infections and osteolysis around the pins (18). Fortunately these complications resolved after the fixator was removed and the stifle joint had a satisfactory range-of-motion.

Although the patient had not displayed any signs of clinical deterioration, the screws were removed for two reasons. Based on the degree of osteolysis, it was assessed that the screws did not contribute much to the stability of the graft and an infection could not be excluded. It was not possible to determine if adequate incorporation of the graft had been achieved at this point, considering the fact that cortical grafts can take from 10 to 37 weeks to heal (19). The screws were removed via a minimally invasive approach under fluoroscopy to minimize surgical exposure of the joint and disturbance of the healing process of the graft. An arthrotomy would have provided the chance to visualize the graft integrity and incorporation, but it may also have increased the risk of morbidity development. Since bacteriological culture of the screws was negative it is uncertain if infection was indeed the cause of the osteolysis although the radiographic findings at the next follow-up did not show any signs of osteomyelitis. The degree of osteolysis around the proximal screw could have been caused by necrosis of the bone graft. Cortical bone grafts can have islands of necrotic tissue several years after implantation (19). Healing takes place by endosteal and periosteal proliferation and can be difficult to assess on radiographs (19). Computed tomography would have provided further information on the incorporation of the graft at the final follow up examination. However computed tomography is less valuable before removal of implants such as screws due to beam-hardening artefacts.

In conclusion we have reported the surgical management of a fracture of the medial trochlear ridge occurring as a postoperative complication following trochlear block recession for treatment of medial patellar luxation in a dog. Transposition of a non-vascularized iliac autogenous bone graft stabilized with screws could be considered as a surgical option in similarly affected cases.

Conflict of interest
None to declare and no funding was received.

References