Introduction

A bone cyst is a benign intraosseous lesion lined by a thin layer of connective tissue and containing a clear or serosanguineous fluid (1). Bone cysts most commonly develop within the proximal or the distal metaphysis of long tubular bones, adjacent to the growth plate and typically migrate away from the growth plate as bone growth occurs (1, 2). Patellar cysts are very rare in humans (2-7). An extensive review of the available literature failed to reveal any reports of patellar cysts in the dog.

Bone cysts are diagnosed more frequently in young (5-15 months of age), medium and giant size dogs, but a female Yorkshire Terrier was also reported to have a bone cyst (1, 8). The German Shepherd dog and Doberman Pinscher are more commonly affected than other breeds, and males seem to have a predilection to bone cysts (1). These lesions are usually benign but malignant transformation and pathological fractures secondary to the presence of bone cysts have been reported in dogs (8-10). A chondrosarcoma arising within the same region of a previous histologically documented bone cyst has been described in a boy (11). Unicameral bone cysts have also been reported as a possible cause of growth disturbance leading to limb shortening and deformity in five children (12).

The overall prevalence of canine bone cyst is unknown. Bone cysts account for approximately three percent of all bone tumours in humans (2, 4, 13, 14).

It was suggested that the principal aetiological factor is blocked drainage of interstitial fluid in fast remodelling bone (15). Others have noticed a slightly higher internal pressure in bone cysts than in contralateral normal bone marrow (16, 17). It was also suggested that venous obstruction was a likely cause of bone cyst formation (19). Pseudocysts and true cysts due to impaired blood supply and ischemic chondronecrosis have been reported recently in horses (17). It was tentatively suggested that an underlying osteochondrosis disease process might lead to cyst formation (17). Increased lysosomal enzyme activity in cystic fluid might play a role in bone corrosion and bone cyst formation (18). High levels of cytotoxic oxygen free radicals were detected in the bone cyst fluid and it was suggested that these oxygen scavengers might contribute to the bone corrosion (19). A specific chromosome aberration associated with amino acid substitution was reported in a patient that developed a recurrent bone cyst (20). An iatrogenic bone cyst resulting from arthroscopic chondroplasty and subchondral bone perforation developed in one human patient (21). Cystic lesions of the distal radius and ulna have been found in Doberman and Old English Sheepdog litters and their parents suggesting a genetic predisposition (22, 23). Clinical signs associated with bone cyst include pain upon palpation and lameness, particularly after prolonged exercise or when the cortex is thinned to the point of generating pathological fractures (2, 4, 5, 7, 12, 14, 22, 24). The cyst may be completely asymptomatic in which case the diagnosis is made as an incidental finding (1). Cystic bone lesions are diagnosed by radiographic, computed tomographic (CT), or magnetic resonance imaging (MRI) examination (1, 2, 7, 25-27). Three-phase bone scintigraphy shows increased vascularity.

Keywords
Patella, bone, cyst, dog, canine

Summary
This report describes a case of a solitary unicameral patellar bone cyst in a young dog. A five-month-old, male Dobermann Pinscher dog was referred for a 10-day left hindlimb lameness. A mild swelling of the peripatellar soft tissues of the left patella was detected upon physical examination. Signs of pain were elicited upon direct palpation of the patella. Radiographic examination revealed an oval radiolucency within the medullary cavity at the base of the left patella. Radiographic examination, arthroscopy, and histopathological findings supported the diagnosis of a benign patellar bone cyst. The condition was treated by surgical curettage and autogenous bone graft harvested from the ipsilateral proximal tibia. Clinical signs, including lameness and signs of pain upon deep palpation, disappeared three weeks after surgery. Follow-up re-evaluation five years after surgery revealed no recurrence of the cyst and the patient was asymptomatic.
and an area of increased radiotracer uptake over the affected patella (28).

Radiographic changes appear as a well-defined rounded radio-opaque lesion filled with a radiolucent core. The bone cyst is often divided into small trabecular septa (1, 2, 7). Histopathological findings of bone cyst include a fibrous tissue wall, collagen fibre production, granulation tissue, and multinucleated cells (2-4, 8, 29). The centre of the cyst resembles plasma, or a serosanguineous exudate (1, 2, 4, 21, 22).

The differential diagnosis in dogs includes subchondral cysts, aneurysmal cysts, bacterial or mycotic osteomyelitis, fibrous dysplasia, blastomycosis, subperioskeletal haematoma, and neoplasia (1, 8-10, 23, 24, 29). Symptomatic bone cysts are typically treated by curettage of the cystic cavity followed by cancellous bone grafting (1, 2, 22, 30). Combined grafting using bovine and autogenous cancellous bone biomaterial and bone cement filling has been described (31). Complete resection of a bone cyst is recommended, but subtotal resection may only be possible in certain cases, including bone cysts involving sesamoid bones (1, 2, 6, 7, 14). Increased prostaglandin E2 levels in the cyst fluid may explain the beneficial effect of steroid therapy (32). A patellar cystic lesion was also successfully treated in one human patient using a cast for four weeks (5).

Case report
Signalment and history
A five-month-old male Doberman dog weighing 28 kg was evaluated due to left hindlimb acute-onset lameness of 10 days duration. The owner had not observed previous trauma. According to the owner, walking and standing exacerbated lameness. The patient was initially treated with carprofen (2 mg/kg) administered orally, twice daily for 10 days. The dog showed a slight, temporary improvement until the drug was discontinued. The physical examination was normal except for severe lameness of the left hindlimb during walking and trotting (Figure 1a). The dorsal surface of the left stifle was slightly swollen, particularly over the patella. Deep palpation of the left patella elicited signs of pain. Signs of pain were also elicited upon hyperflexion of the left stifle but not on hyperextension. The left stifle had a normal range-of-motion both in flexion and in extension, and no mediolateral instability was evident. The drawer sign and the tibial thrust sign were mildly positive with an abrupt end, consistent with joint laxity.

Diagnosis and treatment
Radiographic examination of the left stifle revealed signs of an oval radiolucent area at the base of the patella (7.5 mm x 4 mm on the mediolateral view) (Figure 1b). The contralateral stifle was radiographically normal. Based on the radiographic findings, bone cyst, osteomyelitis and bone neoplasia were considered as possible causes. The rounded radiolucency was well demarcated from normal bone and showed no expansion of the cortex or periosteal proliferation. No evidence of pathological fracture was seen. Radiography of the thorax revealed no abnormalities. Haematology investigations were normal. Needle aspirate and tissue biopsies were recommended. A CT scan was also suggested to obtain a better three-dimensional view of the lesion. The owner refused these procedures. Cage rest, leash walking, and non-steroidal anti-inflammatory drug medication were prescribed. The dog was discharged.

At clinical re-examination six days later no improvement was noticed. The dog was sedated for radiographs, which revealed an increase in the size of the radiolucent area at the base of the patella (8.5 mm x 5 mm on the mediolateral view) (Figure 2b). Fine needle aspiration, biopsy and CT scan were again recommended, but the owner again declined. Cage rest, leash walking, and non-steroidal anti-inflammatory drug treatment were continued. After another six days the dog was re-evaluated and no changes in clinical signs were noted. The dog was again sedated and radiographs repeated. The bone lucency had further increased in size to 9.5 mm x 6 mm (Figure 2c). Six days later preoperative radiographic examination performed under general anaesthesia revealed a 10 mm x 6 mm radiolucent area on the mediolateral view (Figure 2d). Fluid aspirated from the cyst was serosanguineous. Subsequent cytological microscopic examination showed moderate cellularity with osteoclast-like giant cells, fibroblasts, and some macrophages in a blood-rich cell background.

A diagnostic arthroscopic examination of the left stifle was then performed with the dog positioned in dorsal recumbency to assess the overall joint condition. Arthroscopy was performed using a 2.7 mm, 30 degree oblique arthroscope. An arthroscope portal was established at the level of muscular groove, just lateral to the patellar ligament. A medioproximal outflow portal and a medial instrument portal were established. The joint structures were examined arthroscopically and appeared normal. The articular surface of the patella was smooth and white and appeared normal. The insertion of the patellar ligament on the apex of the patella also appeared normal. Synovial villous hypertrophy and hyperaemia were observed. After arthroscopy, a Robert-Jones bandage was applied with the stifle in extension to avoid any tension on the patellar ligament. Amoxicillin and clavulanic acid (20 mg/kg, BID) for 10 days and meloxicam (0.1 mg/kg, SID, PO) for 10 days were prescribed.
Cytological examination and radiographic findings were consistent with unicameral bone cyst. One week later, the dog still had grade 3/5 left hindlimb lameness. Surgical treatment of the patellar lesion was recommended and performed. A 3 cm skin incision was performed through a patellar mid-line approach. The quadriceps tendon was longitudinally incised from proximal to distal directly over the location of the cyst. The dorsal cortex of the patella was observed to be very thin in this area. The cystic cavity was inspected by introducing a 2.3 mm 30 degree oblique arthroscope through the thin cortex. The endoscopic view of the cystic cavity revealed reddish spongy spurs spreading inside the cavity. The cavity was filled with serous-like fluid. There were no breaches of the cortex of the cyst (▶ Figure 4). The cyst cavity was curetted with a 4 mm diameter Volkmann curette. The material gathered was submitted for histopathology. An autogenous cancellous bone graft was harvested from the medial aspect of the proximal left tibia and grafted into the cystic cavity (▶ Figure 5a, ▶ Figure 6a). Separate instruments were used to collect the bone graft. The dog was discharged the following day. Cage rest as well as antibiotic and anti-inflammatory therapy were continued as previously described. The histological examination of the biopsy contents was consistent with dystrophic osteocartilaginous material featuring wide areas of necrosis.

A diagnosis of unicameral bone cyst was made on the basis of clinical, radiographic, endoscopic, and histological findings. Two weeks later, the dog showed a grade 2/5 lameness and signs of mild pain upon patellar palpation. Twenty days after surgery the lameness had resolved at clinical examination. No signs of pain were elicited upon patellar palpation. A fractured proximal-dorsal cortex of the patella with fragmentation and bone remodelling and patellar apex bone elongation was observed on the mediolateral view of the patella (▶ Figure 5b). Five weeks after surgery the radiographs confirmed bone elongation at the patellar apex, fracture, and further bone remodelling at the base of the patella (▶ Figure 5c, ▶ Figure 6b). Muscle circumference and tone were normal and symmetric compared with the contralateral limb three months following surgery. Rounded radiolucent spots at the base of the patella and remodelled patellar apex were seen at this time (▶ Figure 5d). A small osseous bulge was noticed on the most dorsal aspect of the bone consistent with an area of smooth periosteal proliferation (▶ Figure 5d). The dog had normal symmetrical hindlimb muscle tone bilaterally and no evidence of lameness was observed during walking or trotting at the eight month follow-up examination. Palpation of the stifle and the patella did not elicit any signs of pain. Radiographic examination showed rounded radiolucent spots at the base of the patella. Further remodelling of the patellar apex was detected. Dorsal smooth periosteal proliferation was evident. The sagittal view showed bone remodelling at the base of the patella (▶ Figure 5e, ▶ Figure 6c). At the five year follow-up, the radiographic mediolateral view showed slightly more re-

Figure 2  Serial radiographs of the left patella. Patellar base is located on the right. Mediolateral view of preoperative plain radiographs showing a lytic, quickly growing radiolucent lesion involving the base of the patella. Note the thinned cranial cortex. a) At presentation, b) six-day follow-up, c) three-week follow-up, and d) four-week follow-up.

Figure 3  Serial radiographs of the left stifle. Craniocaudal projections show a lytic, quickly growing radiolucent area, located at the base of the patella. a) six-day follow-up, b) three-week follow-up, and c) four-week follow-up.
modelling than in the previous radiograph (Figure 5F).

Discussion

In this case, the rapid and progressive enlargement of the bone cyst and equally rapid resolution of symptoms after opening the cyst are supportive of previous suggestions with regard to the aetiopathogenesis (15, 16).

Bone cysts are rare and previous reports do not support trauma as a cause (2, 3, 5-7). In this case there was no definite previous history of specific trauma that could be related to the onset of symptoms of this dog.

The diagnosis of a patellar cyst was based on radiographic and histopathologic findings that were consistent with the previous literature (1, 2, 4, 23, 27). Computed tomographic scan and MRI allow a better evaluation of the three-dimensional architecture of the bone; however, neither CT scan nor MRI is considered essential to establish the size and location of patellar bone cysts.

The presence of cartilage in the biopsy specimen introduces the possibility that an underlying osteochondrosis lesion could lead to the formation of the cyst (17).

We were able to observe changes in the morphology of the patella by comparing radiographic images over a five-year period. The mediolateral view was preferred to avoid both superimposition by the femoral shaft and the need for general anaesthesia. Remodelling of the base and apex of the patella occurred over the course of time (Figure 5). The base of the patella eventually fractured with fragmentation over time following surgery and was partially reabsorbed as elongation of the patellar apex occurred. Gradual remodelling of the patella was probably due to the biomechanical forces exerted on the patella in accordance with Wolff's law of bone remodelling.

According to the human and veterinary literature, cystic bone lesions have been reported to resolve after cystic cavity curettage alone, after curettage and bone grafting, and after intra-lesional steroid injection (1-3, 7, 14, 30, 31, 32). Resolution has also been reported to occur with conservative treatment (5, 23). Perforation of the cyst, either surgical or incidental, might be a possible common denominator and cause for resolution of lameness and pain. Clinical resolution in this case occurred before possible graft incorporation and radiographic bone healing. Clinical improvement after opening the cyst may be due to reduced intra-compartmental pressure within the medullary cavity of the patella. If increased intramedullary bone pressure is a cause of bone cyst formation, early treatment to decrease pressure might lead to cessation of growth or resolution of the cyst. Possible methods to decrease medullary bone pressure include needle aspiration or trephination.
Other possible bone cyst treatments such as the use of polymethylmethacrylate, ceramic scaffolds, demineralized bone matrix, and bone morphogenetic protein could also be considered. Persistent lameness and the rapid and progressive growth of the patellar bone cyst suggested that early intervention was indicated in this case.

Conflict of interest
There are no conflicts of interest to declare.

References