Periprosthetic fracture in a cat

We describe the case of a periprosthetic fracture in a 9-year old, European Shorthair cat weighing 7.3 kg. The fracture occurred as a result of a fall, 2 weeks after implantation of a cemented Micro-THR-System hip prosthesis. The fracture was classified as type B1 according to the Vancouver classification. The fracture was anatomically reduced and stabilised using a locking plate with two monocortical screws, four bicortical screws and two cerclage wires. At follow-up after 3 weeks, the cat was weight-bearing but limping. At the 5-week follow-up, and subsequently (at 10 weeks, 6 months and 2 years), the cat's ambulation was normal. At the 10-week follow-up, the fracture was radiographically healed. At the 2-year follow-up the cat was walking normally and had no radiographic evidence of osteolysis around the screws or bone reabsorption due to stress protection.

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INTRODUCTION

The prevalence of hip dysplasia in the cat was found to be 6.6% in a study of 684 cats [1]. This condition occurs more frequently in females and pure bred cats, although it has also been recorded in European Shorthair cats [2-4]. Feline hip dysplasia is usually bilateral and may result in pain and osteoarthritis [3, 5]. It can be treated surgically by ostectomy of the femoral neck and head or by means of total hip replacement [6-8]. In cats, in a comparative retrospective study between ostectomy of the head and neck of the femur and a cemented hip prosthesis with the micro total hip replacement (MTHR) system, the hip prosthesis provided better results from the clinical point of view [6]. The reported complications after cemented hip replacement in dogs are infection, dislocation, failure (septic or aseptic), femoral fracture, pulmonary embolism, formation of a cement granuloma and intramedullary infarction [9-16]. The reported complications following MTHR in small dogs (<12 kg) are luxation, loosening of the acetabular cup, fracture of the femur and sciatic neuropraxia [7, 8]. Loosening of the acetabular component, dorsal dislocation of the femur and medial dislocation of the patella are the complications reported in the literature following 19 cases of MTHR in the cat [6-8, 17-19]. A periprosthetic fracture is defined as a complete femoral fracture around the stem or immediately distal to it [20]. To the authors' knowledge, no postoperative periprosthetic fractures after application of MTHR in the cat have been reported. Here we report a case of post-MTHR periprosthetic fracture in a cat and its subsequent surgical treatment.

CASE REPORT

Signalment and history

A spayed, 9-year old European Shorthair cat weighing 7.3 kg was referred because of persistent, left hind limb lameness for about 3 months. The cat lived in a house. There was no history of recent or past trauma.

The prevalence of hip dysplasia in the cat is 6.6%. From a clinical point of view, the best surgical treatment is hip replacement.

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Clinical picture

The orthopaedic examination evoked a reaction in the cat (avoidance of manipulation) during extension and hyper-extension with external rotation of the left hip joint. The neurological examination did not reveal any abnormalities. Blood-biochemistry tests and urinalysis were normal.

Differential diagnosis

The differential diagnosis included dislocation/subluxation of the left hip joint, osteoarthritis of the hip/hip dysplasia, and traumatic/pathological fracture of the proximal femur or pelvis.

Diagnostic procedures

The cat was pre-medicated with methadone 0.2 mg/kg subcutaneously and anaesthesia induced with propofol 5 mg/kg intravenously in order to take X-rays. The anaesthesia was maintained with 1.5% isoflurane in oxygen. The radiographic study included a mediolateral view of the left femur and the standard ventrodorsal view of the pelvis. (Figure 1A,B) [21]. The standard ventrodorsal view of the pelvis showed subluxation and acetabular flattening with osteophytes at the dorsal acetabular rim (osteoarthritis of the coxofemoral joint), leading to the radiographic diagnosis of bilateral hip dysplasia [1, 22, 23, 24]. The same view showed a lumbosacral transitional vertebra (Figure 1B) [5, 25]. A latero-lateral X-ray of the lumbosacral spine was, therefore, taken. This latero-lateral view of the spine showed lumbar spondylosis between L6 and L7 [25] (Figure 1C).

Computed tomography of the lumbosacral spine was then performed. The computed tomography scans confirmed the diagnosis of a lumbosacral transitional vertebra and spondylosis, and showed asymmetry of the sacroiliac joint without rotation of the pelvis in the three planes of space [25] (Figure 2A-C). 3D volume rendering was processed by OsiriX MD software, version 6.5.2 64-bit.

X-rays of the patient showed acetabular flattening, osteophytes on the dorsal acetabular margin and a lumbosacral transitional vertebra.

Therapy and evolution

In the following 3 months, the cat was treated three times with anti-inflammatory therapy (Meloxicam 0.05 mg/kg q24h for 15 days) and rest (confinement in a cage) without success. Hip replacement surgery was then proposed and accepted. Before surgery, cranio-caudal and mediolateral radiographs of the femur were performed to allow preoperative planning. The radiographs were calibrated with a radiopaque calibration ruler. Surgery was performed using the same anaesthetic protocol as that

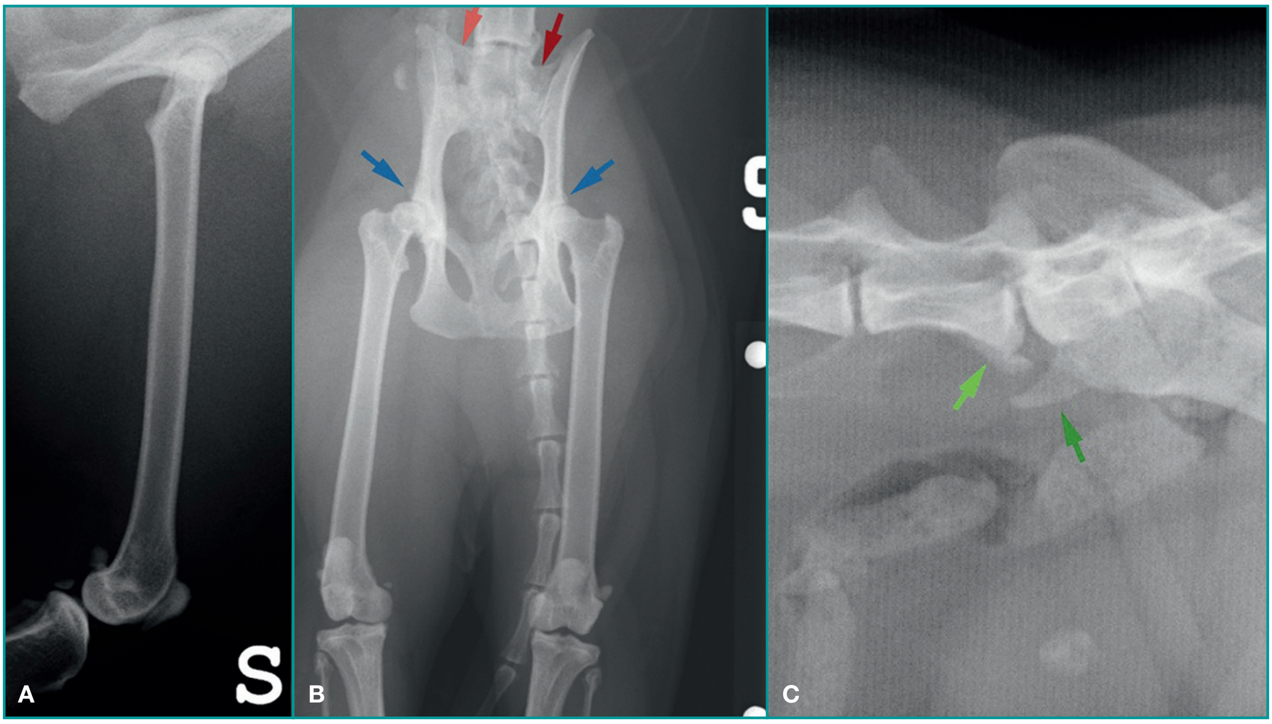

Figure 1 - (A) Mediolateral view of the left femur. (B) Ventrodorsal view of the pelvis. Osteophytes of the craniodorsal acetabular margin (blue arrows) and the lumbosacral transitional vertebra (red arrows) are evident. Note also the bilateral acetabular flattening in the absence of alterations of the femoral head and neck. (C) Lumbosacral spondylosis (green arrows).

VETERINARIA

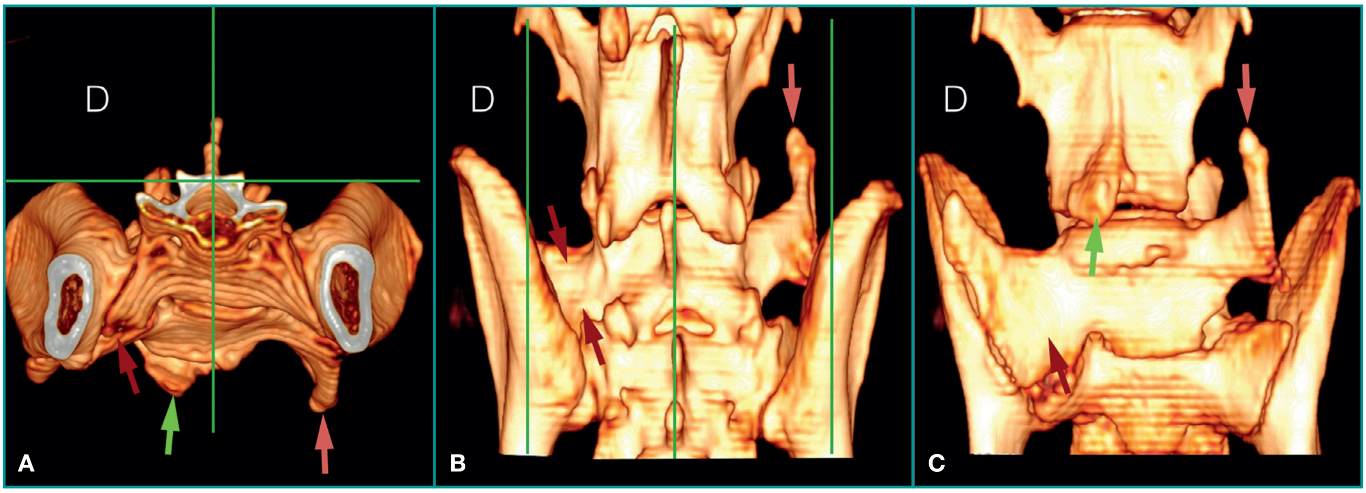

Figure 2 - (A-C) 3D reconstruction from the computed tomography study of the pelvis and of the lumbosacral spine. The 3D reconstruction demonstrates that the pelvis is not rotated with respect to the vertebral axis. The red arrows indicate the lumbosacral transitional vertebra while the green arrows point to the spondylosis.

used for the radiographic study. Intraoperative analgesia was obtained with a continuous infusion of fentanyl (10 µg/kg/h). Antibiotic prophylaxis consisted of cefazolin sodium 22 mg/kg, administered intravenously 30 minutes before skin incision.

A cranio-dorsal surgical approach was taken to the left hip joint [26]. A cemented MTHR prosthesis (Micro Hip System: BioMedtrix, Boonton, NJ, USA) [27], with a 12 mm cup, # 2 stem, and 8+0 mm head, was then introduced [6, 27].

The post-operative radiographic survey included the standard ventrodorsal and mediolateral projections of the treated femur (Figure 3A,B) [6, 21, 22, 27].

The acetabular component was seen to be oriented correctly, while the stem had a varus alignment. No periprosthetic radiolucent lines were present, indicating that the cement mantle was adequate [7, 8, 27, 28].

Meloxicam was administered orally at a dose of 0.05 mg/kg q24 for 7 days as post-operative anti-inflammatory treatment. A 7-day course of antibiotic therapy with amoxicillin + clavulanic acid (20 mg/kg BID per os) was also prescribed. The patient was discharged the day after surgery and the owners were instructed on the postoperative course. It was explained

A periprosthetic fracture is a possible complication following implantation of a prosthetic hip in a cat.

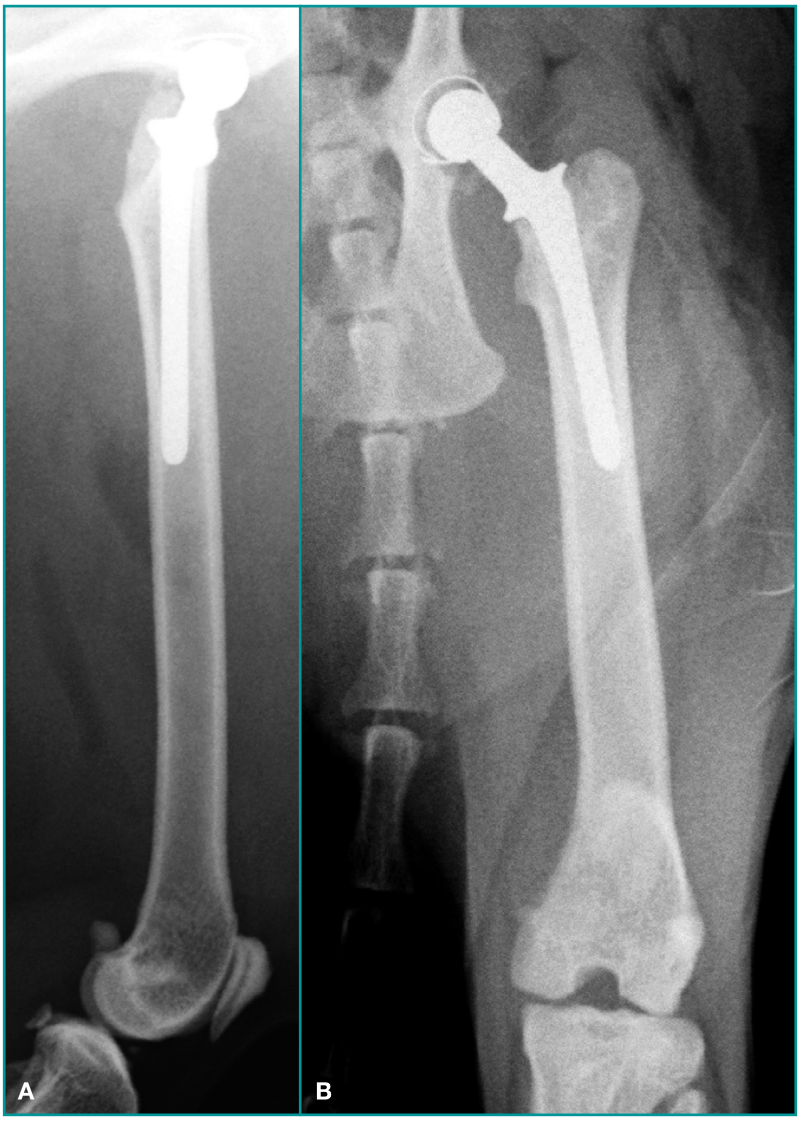

Figure 3 - Postoperative radiographs: (A) mediolateral and (B) anteroposterior views of the left femur. The stem of the prosthesis is in varus in the frontal plane.

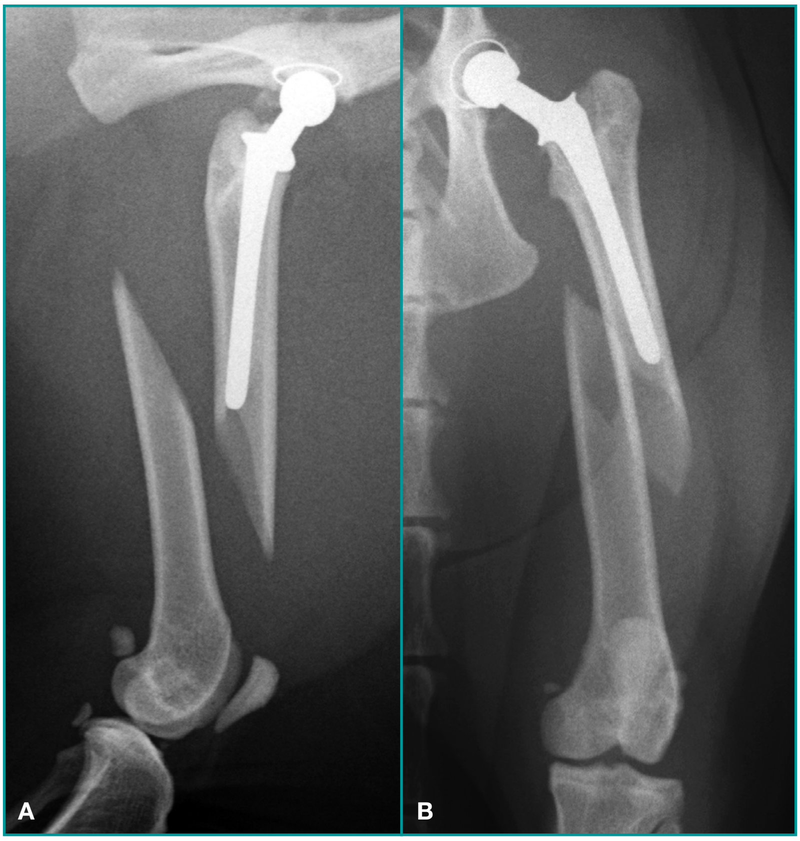

Figure 4 - (A) Mediolateral and (B) anteroposterior views of the femur after the fracture. The fracture was classified as a complete oblique fracture of the middle third of the femoral shaft.

that the cat should be confined in a cage for 8 weeks after surgery, allowing it to come out four times a day, for 20 minutes each time, under supervision to avoid jumping and running but to promote the use of the limb and prevent muscle wasting.

Two weeks after surgery the cat was brought to the clinic because of sudden left hind limb lameness with loss of weight-bearing capacity following a fall. The owners reported that the cat had never been kept in a cage to avoid the constant meowing caused by confinement. An orthopaedic examination could not be performed because the cat resisted manipulation. It was, therefore, anaesthetised using the same anaesthetic protocol described above and cranio-caudal and mediolateral X-rays of the left femur were obtained [21, 22, 27] (Figure 4A,B). The radiographs showed a complete, oblique periprosthetic fracture, classified as a type B1 fracture according to the Vancouver classification [29] (Figure 5).

Open reduction and fixation of the fracture was planned for the next day and performed with the application of the same anaesthetic, analgesic and prophylactic antibiotic protocols described above. A lateral surgical approach to the femur was used [30]. After anatomical reduction of the two fragments of the fracture, a stable-angle plate was positioned on the lateral side of the femur (Fixin V2204: length 92 mm, thickness 2 mm, 6 holes, 1.9 to 2.5 mm series) [31]. The plate was fixed with six locking screws and two cerclage wires: in a proximal to distal direction, screws 1, 3, 4, 5, and 6 had a diameter of 2.5 mm, while screw 2 had a diameter of 1.9 mm. Screws 1, 4, 5, and 6 were bicortical while screws 2 and 3 were monocortical. The cerclage wires had a diameter of 1 mm and were tightened over the plate using a single loop cerclage knot technique [32, 33] (Figure 6A,B). Post-operative X-rays showed anatomical reduction of the fracture and correct alignment of the femur. The cat was discharged the next day with the same recommendations as those given after implantation of the prosthesis and

A locking plate with monocortical and bicortical screws, combined with cerclage wires, was used to stabilise the type B1 complete, oblique periprosthetic fracture.

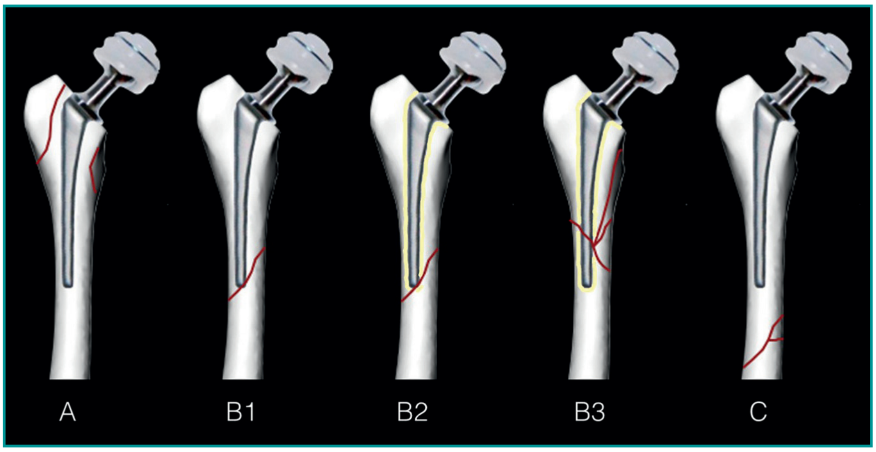

Figure 5 - Vancouver classification. Type A: the fracture is proximal and involves the greater and lesser trochanters. Type B1: the fracture is at the level of the distal end of the stem in the presence of a stem stably anchored in the proximal fracture fragment. Type B2: the fracture is at the level of the distal end of the stem in the absence of a stem stably anchored in the proximal fracture fragment. Type B3: the fracture is at the level of the distal end of the stem in the absence of a stem stably anchored in the proximal fracture fragment in addition to comminution and to possible loss of substance (not reducible fragments). Type C: the fracture occurs distal to the distal end of the stem.

with the same pharmacological treatment. Clinical and radiographic follow-up controls were scheduled at 3, 5, and 10 weeks, 6 months and 2 years. All radiographs were performed with the patient under sedation (dexmedetomidine 5 µg/kg intramuscularly). At the 3-week follow-up the cat still had a synchronous, second-degree lameness involving the left hind limb [34]. At 5 weeks and at subsequent controls, the animal's gait was normal (Video). The X-ray follow-up at 3 weeks showed remodelling at the fracture plane and incomplete callus formation at the caudal and medial cortex (Figures 7A and 8A). At 5 weeks the X-rays indicated that the implant was stable and there was progressive bone callus formation (Figure 8B). At the 10-week radiographic follow-up, bone healing had been completed (Figure 8C). At 6 months the mediolateral X-ray showed remodelling of the callus and confirmed the stability of the implant and prosthesis (Figure 7B). The radiographic study at 2 years showed that the implant was stable, there was no osteolysis at the bone/screw interface and no periprosthetic radiolucent lines were present (Figure 8D).

The cat's gait 10 weeks after reduction of the femoral fracture
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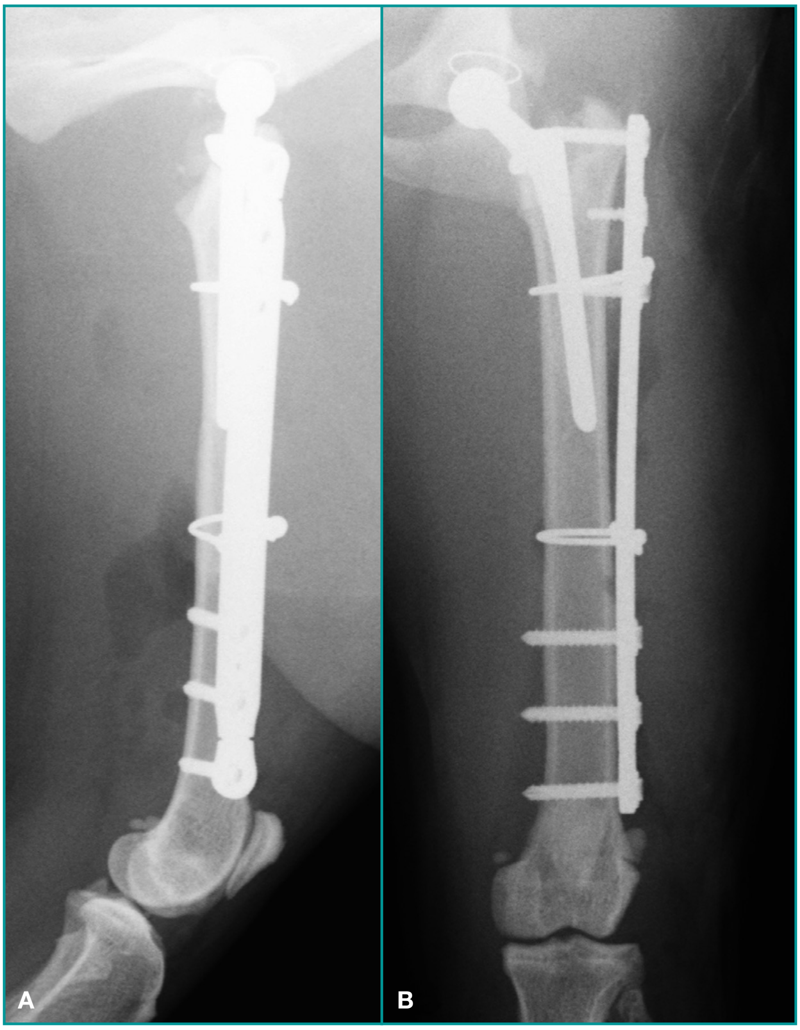

Figure 6 - (A) Mediolateral and (B) anteroposterior control X-rays of the femur after open reduction and internal fixation using a locking system and two cerclage wires. The second and third screws in a proximal-distal direction are monocortical screws.

DISCUSSION

Lumbosacral transitional vertebrae have been described in cats [25]. Such vertebrae have been associated with sacroiliac joint asymmetry, rotation of the pelvis with respect to its dorsal plane, spondylosis and hip dysplasia [25]. In the same study the prevalence of spondylosis was higher in patients with lumbosacral transitional vertebrae than in those without, although the difference was not statistically significant. The tendency to develop spondylosis was greater in patients with pelvic rotation or asymmetry of the sacroiliac joints. The prevalence of hip dysplasia was the same in patients with or without lumbosacral transitional vertebrae [25]. The cat described in this case report had a lumbosacral transitional vertebra, bilateral hip dysplasia, and spondylosis in the absence of pelvic rotation.

In the cat, hip dysplasia seems to occur preferentially in some breeds, such as Himalayan, Main Coon and Persian cats, in which the prevalence is 25%, 21% and 16%, respectively [1]. The prevalence in the European Shorthair cat has been reported to be 6% [1]. It has been suggested that the higher prevalence of the disease in certain breeds could be the consequence of these animals being of larger size rather than the fact of belonging to a particular, specific breed [1]. The case described here refers to a European Shorthair cat weighing over 7 kg.

The radiographic signs of hip dysplasia differ between cats and dogs [1, 2, 5]. Cats have a flattened acetabular cavity and periosteal proliferations at the level of the cranial-dorsal acetabular rim with minimal signs of remodelling of the femoral neck [1, 2, 5]. The cat presented in this case report had these radiographic signs

The oblique position of the prosthetic stem could have been a cause of the fracture.

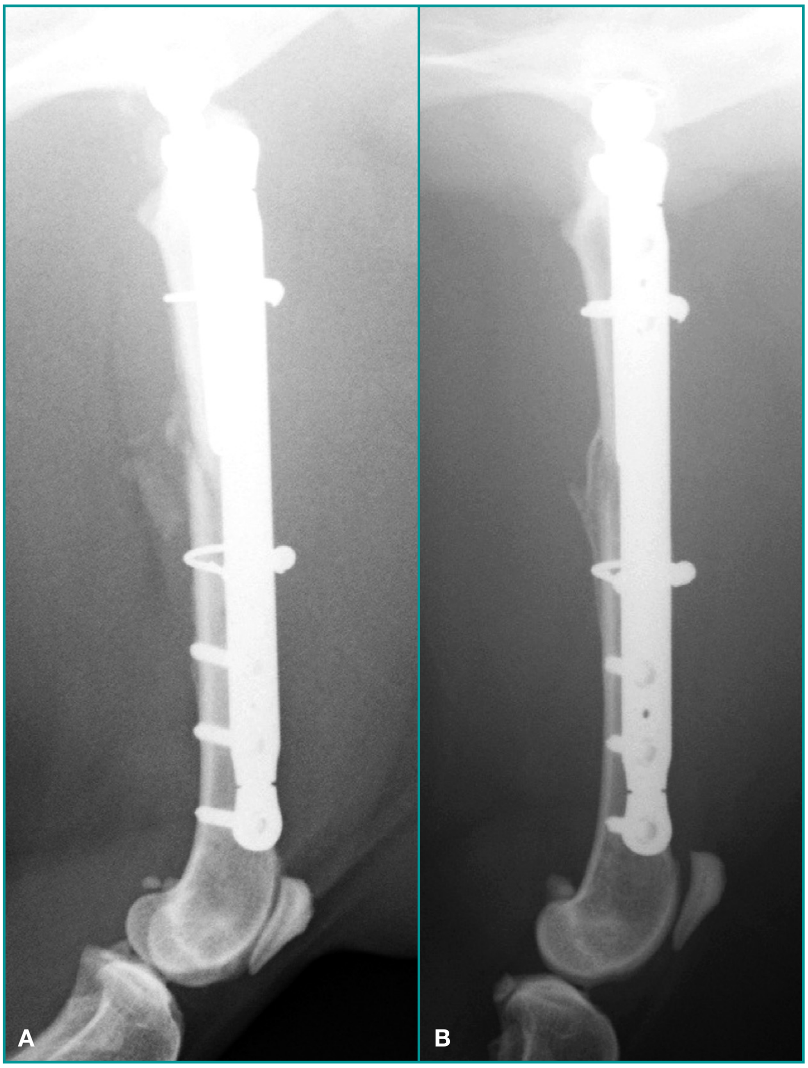

Figure 7 - Mediolateral X-rays of the femur: (A) control at 3 weeks, (B) control at 6 months.

bilaterally although it was only symptomatic when bearing weight on the left hind limb. This can be explained by the greater degeneration of the left hip joint than of the right one. The difference between the two joints was not appreciable radiographically. Arthroscopy or magnetic resonance imaging would have helped to clarify this aspect.
The surgical options for the treatment of hip dysplasia in cats are ostectomy of the head and neck of the femur and implantation of a prosthetic hip [6, 17, 28]. According to one study, from a clinical point of view hip replacement gives better results than femoral head and neck ostectomy, although the evaluation was subjective [6].
The stem of the prosthesis should be inserted so that it is coaxial with the long axis of the bone on the frontal and sagittal planes [27]. In our case the stem was coaxial with the sagittal plane but in varus with respect to the frontal plane. This misalignment may have been the cause of the fracture when the cat jumped down from a height. The stem, with its oblique orientation, may have acted as a lever, causing the fracture. We have no way of knowing whether the fracture would have occurred at some time or not anyway, even without jumping. The stem should be implanted in line with the anatomical axis of the proximal femur in both the sagittal and frontal planes. The central axis of the femur is identified from the intertrochanteric fossa. The axis is formed by a straight line joining this point with the centre of the patella in the frontal plane and from this point along the anatomical proximal femoral axis according to preoperative planning and the curvature of the femur (procurvatum), measured in the mediolateral X-ray. This step can be performed either before or after the ostectomy of the femoral neck and head. Performing the operation with the neck and head still present may facilitate orientation during preparation of the femoral canal for positioning the stem [27]. In our case, the surgeon prepared the femoral medullary canal after performing the neck and head ostectomy, thereby losing anatomical references for orientation in space. As a result, the femoral stem was in varus with the frontal plane.
In human orthopaedics, periprosthetic fractures are categorised according to the Vancouver classification [29]. The stabilisation method of choice involves internal fixation using locking plates [29, 35].
The prevalence of periprosthetic fractures in dogs varied from 1.5% to 7.9% in two studies; most of the fractures were Vancouver type B1 or B2, and generally occurred within 2 weeks of implanting the prosthesis [36, 37]. The prevalence of periprosthetic fractures in cats is unknown. The fracture in the cat described in this case report occurred 2 weeks after the joint replacement surgery and was Vancouver type B1 (Figure 5).

A locking plate is the method of choice for reducing periprosthetic fractures.

Bone resorption secondary to suspected stress protection after the placement of locking plates to treat a femoral non-union has been described in veterinary medicine [38]. The radiographic study for up to 2 years after the surgical revision of the cat described in this case report showed no signs of bone resorption. It is possible that the rigidity of the implanted system

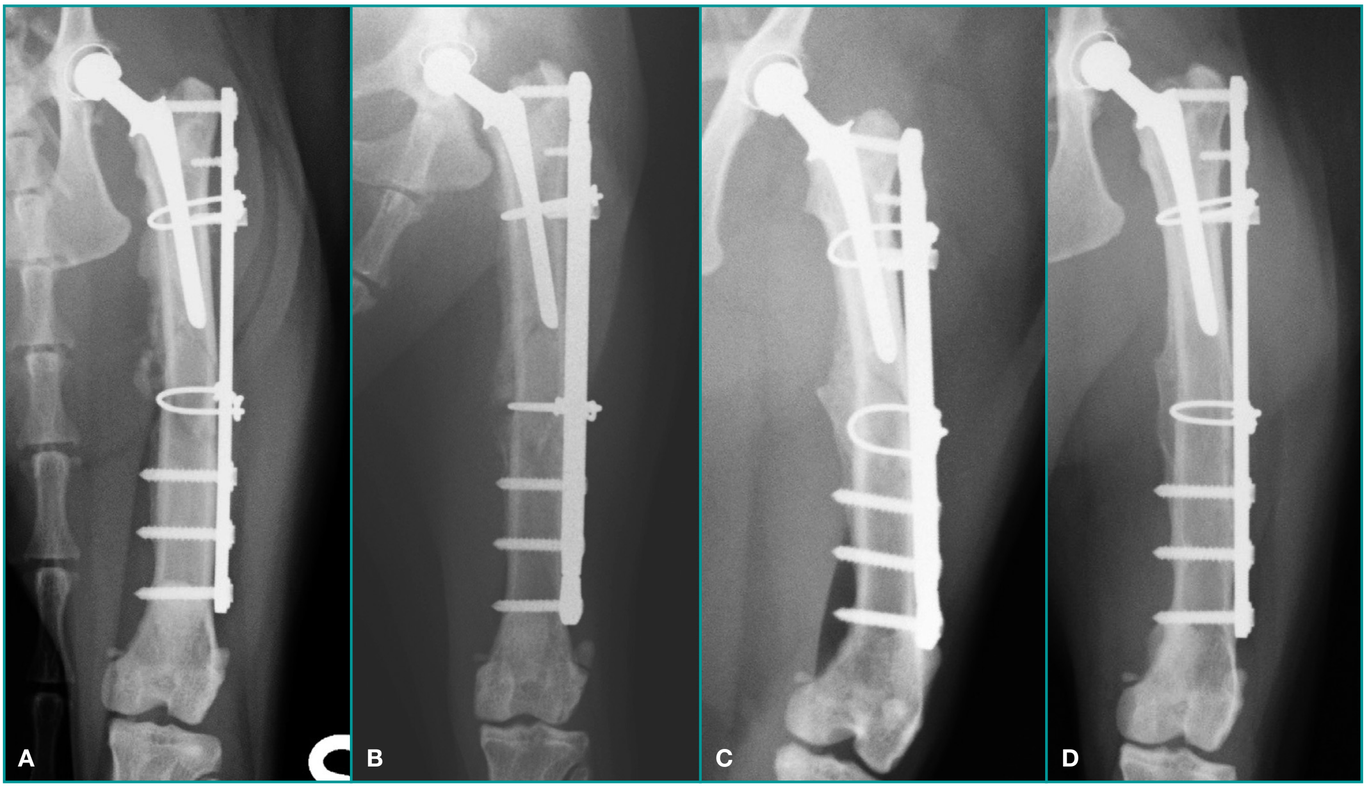

Figure 8 - Anteroposterior X-rays of the femur: (A) control at 3 weeks, (B) control at 5 weeks, (C) control at 10 weeks, (D) control at 2 years.

did not differ so significantly from that of the bone as to generate stress protection in this patient.

The femoral fracture was treated with a combination of monocortical and bicortical screws. The use of two monocortical screws in the proximal fragment of the fracture was dictated by the encumbrance of the prosthesis stem within the medullary canal.

In biomechanical studies in both veterinary medicine and human medicine it has been seen that systems for the treatment of periprosthetic fractures that involve bicortical screw fixation are stabler than those with monocortical screw fixation [39, 40]. However, in the case of failure of the implant, femora treated with bicortical screws may develop comminuted fractures while in the case of monocortical fixation the consequence is only pull-out of the screws [39].

To increase the stability of the system, and to compensate for the lack of bicortical fixation screws, which could not be used because of the presence of the prosthesis stem in the medullary canal, two over-plate cerclage wires were added. The use of locking systems together with cerclage wires has been described in dogs and humans [41, 42]. Biomechanical studies in human medicine have shown that the use of extra cerclage wires increases the stability of the systems [42]. Furthermore, adjunctive fixation with an Advanced Locking Plate System (ALPS) plate was described in a biomechanical study on the prevention of periprosthetic fractures after application of a Zurich-type cementless hip prosthesis [43].

Radiographic controls of a long bone should include two perpendicular views: mediolateral and anteroposterior. Sedation or general anaesthesia may be used in order to acquire these views, with the choice depending on the patient's character/temperament. In the patient described in this case report, permission to perform general anaesthesia was only granted for the initial diagnostic radiographs and for the post-fracture study. At all other controls, the X-rays were taken with the patient alert. This resulted in oblique views or sometimes obtaining a single anteroposterior or mediolateral view. The anteroposterior projection was more suitable for the assessment of fracture healing since, with this view, the implant did not «hide» the underlying femur (Figure 8) as would have occurred with the mediolateral projection (Figure 7).

A lumbosacral transitional vertebra could have been the cause of the bilateral hip dysplasia in this cat.

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KEY POINTS

- Hip dysplasia in cats is more prevalent among large breeds.
- The radiographic signs of hip dysplasia in cats differ from those of hip dysplasia in dogs: femoral remodelling is minimal, while changes to the acetabular cup and cranio-lateral margin of the acetabulum are prominent.
- From a clinical point of view, the most effective treatment is a prosthetic hip replacement. Periprosthetic fracture is one of the potential complications of this operation, although its prevalence in cats is unknown.
- Internal fixation with locking plates has been shown to be the method of choice for reducing periprosthetic fractures in humans. The application of cerclage wires increases the stability of the reduction.
- A lumbosacral transitional vertebrae in the cat can be associated with sacroiliac joint asymmetry, rotation of the pelvis with respect to its dorsal plane, spondylosis and hip dysplasia.

Frattura periprotesica di femore in un gatto

Riassunto

Viene descritto un caso di frattura periprotesica in un gatto comune europeo femmina di 9 anni e 7,3 kg di peso. La frattura avveniva a due settimane dall'applicazione di una protesi cementata tipo Micro-THR-System in seguito ad una caduta. La frattura veniva classificata di tipo B1 secondo la classificazione di Vancouver. Il gatto veniva trattato mediante fissazione interna con placca bloccata con due viti monocorticali e quattro viti bicorticali in aggiunta a due cerchiaggi. Al controllo clinico a tre settimane il gatto presentava una zoppia posteriore sinistra continua, sincrona, di secondo grado. A cinque settimane e ai controlli successivi (dieci settimane, 6 mesi e 2 anni) la deambulazione risultava normale. A dieci settimane la frattura veniva giudicata guarita radiograficamente. A due anni di distanza il gatto aveva una deambulazione normale e non si erano verificati fenomeni di osteolisi in corrispondenza delle viti o fenomeni di protezione da carico.

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