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Case Report

Low-field Magnetic Resonance Imaging of Changes Accompanying Slipped Capital Femoral Epiphysis in a Cat

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Abstract

A one-year-old neutered Maine Coon cat was admitted to the clinic with sudden onset of lameness in the right pelvic leg persisting for around 2 days. A clinical examination revealed lack of weight bearing on the right pelvic limb, minor bilateral atrophy of gluteal muscles and acute pain upon palpation of the right hip joint. Radiographs taken in the dorsoventral projection revealed a large radiolucent area in the proximal femoral epiphysis, surface remodeling of the femoral head and subcartilaginous sclerotization in the right pelvic limb, which were indicative of slipped capital femoral epiphysis. Radiolucent foci on the femoral head was observed in the left pelvic limb. The patient was examined in the Esaote Vet-MRI Grande scanner (0.25 T). The scans revealed complete separation of the femoral head, the presence of a hematoma and bone marrow edema in the right limb, as well as widening of the growth plate, bone marrow edema and the presence of a subcartilaginous cyst in the left limb. Resection arthroplasty of the right femoral head was performed, and the slipped femoral head was subjected to a histopathological examination. The aim of this study was to evaluate the use of low-field MRI for diagnosing slipped capital femoral epiphysis.

Keywords: *Cat, Slipped capital femoral epiphysis, Hip joint, Magnetic resonance imaging, SCFE*

Bir Kedide Kaymış Femur Başı Epifizine Bağlı Değişikliklerin Düşük-alan Manyetik Rezonans Görüntüleme İle Belirlenmesi

Öz

Bir yaşlı ve kısırlaştırılmış Maine Coon ırkı kedi, sağ arka bacakta aniden başlayan ve yaklaşık 2 gün devam eden topallık şikayeti ile kliniğe kabul edildi. Klinik muayenede sağ arka bacağa ağırlık verememe, gluteal kasların hafif bilateral atrofisi ve sağ kalça ekleminin palpasyonu sırasında akut ağrı saptandı. Dorsoventral radyografik görüntülemede proksimal femoral epifizde geniş bir radyolusent alan, femur başında yüzeysel şekil değişikliği ve sağ arka bacakta kaymış femur başı epifizinin göstergesi olan sub-kartilaginöz sklerotizasyon belirlendi. Sol arka bacak femur başında radyolusent odaklar izlendi. Hasta Esaote Vet-MRI Grande cihazı ile (0.25 T) incelendi. Taramalarda sağ bacakta femur başında tam ayrılma, hematom ve kemik iliği ödeminin yanı sıra sol bacakta büyüme plağı genişlemesi, kemik iliği ödemi ve sub-kartilaginöz kist tespit edildi. Sağ femur başına rezeksiyon artroplastisi uygulandı ve kaymış femur başı histopatolojik incelemeye tabi tutuldu. Bu çalışmanın amacı, kaymış femur başı epifizinin tanısında düşük-alan MRG kullanımını değerlendirmektir..

Anahtar sözcükler: *Kedi, Kaymış femur başı epifizi, Kalça eklemi, Manyetik rezonans görüntüleme, SCFE*

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is referred to as a spontaneous fracture of the growth plate without direct trauma [1]. In human medicine this pathology is also determined as a displacement of the epiphysis on the metaphysis through the physis [2]. This progressive disease leads to complete separation of the epiphysis as a result of repeated overloading [1]. In most patients, the etiology of the disease is unknown. In human subjects, slipped capital femoral epiphysis can be caused by biomechanical, genetic and biochemical factors (for example renal failure, endocrine problems or complications after radiotherapy). A combination of these factors weakens the growth plate and increases mechanical forces acting on the epiphysis [2-5]. McNicolas et al.[6] observed that the histological characteristics of slipped capital femoral epiphysis are similar to those noted in growth plate disorders in children, and they include disrupted chondrocyte structure, chondrocyte accumulation, growth plate thickening and surface cracking.

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According to Craig [7], other characteristic features include the formation of fibrous tissue on cartilage surface, multifocal granulation and ossification. In cats older than one year, the four main factors predisposing to slipped capital femoral epiphysis include gender, reproductive status (the disease is more prevalent in neutered males), delayed growth plate closure (which normally occurs between the age of 30 to 40 weeks) and high body weight [6] Slipped capital femoral epiphysis is most prevalent in Siamese cats and domestic short-haired cats, but it has been increasingly reported in Maine Coons in the literature [1,6,8]. Joint diseases in cats often has non-specific symptoms like: lower levels of physical activity, reluctance to jump, decreased appetite, increased thirst and inability to a comfortable resting position [9,10], but SCFE can revelated sudden onset of lameness, pain upon palpation of incorrect joint and atrophy of gluteal muscles. In the present case study, slipped capital femoral epiphysis was diagnosed in a one-year-old neutered Maine Coon male.

CASE HISTORY

A 12-month-old neutered Maine Coon male cat with a body weight of 7.6 kg was admitted to the clinic with sudden onset of lameness in the right pelvic leg persisting for around 2 days. The owners reported on the patient's aggressive behavior and vocalization, but they ruled out the possibility of traumatic injury. A clinical examination revealed lack of weight bearing on the right pelvic limb, minor bilateral atrophy of gluteal muscles and acute pain upon palpation of the right hip joint. Superficial and deep sensation was confirmed in both pelvic limbs. The patient was premedicated with medetomidine (Cepetor, ScanVet, 1 mg/mL) at 0.05 mg/kg BW and butorphanol (Torbugesic, Pfizer Trading Polska, 10 mg/mL) at 0.1 mg kg/BW, and a catheter was inserted into *vena cephalica* to provide venous access. Radiographs of the right and left hip joints were performed in dorsoventral projections. Radiographs revealed a large radiolucent area in the proximal femoral epiphysis, surface remodeling of the femoral head and subcartilaginous sclerotization in the right pelvic limb *(Fig. 1)*. Radiolucent foci in the femoral head was observed in the left pelvic limb *(Fig. 2)*.

General anesthesia was induced with propofol (Provive, Claris Lifesciences, UK, 10 mg/mL) at 2 mg kg/BW. The patient was examined in the Esaote Vet-MRI Grande low-field MRI scanner (0.25 T) in sternal recumbency with the pelvic limbs extended caudally. The hip joints were positioned centrally in a dual-phased array transmit/receive knee coil No. 2. The MRI examination was performed in the Spin Echo (SE T1) sequence in the sagittal (TR 650 ms, TE 26 ms), dorsal (TR 750 ms, TE 26 ms) and transverse (TR 3000 ms, TE 120 ms) plane, in the XBONE sequence in the dorsal plane (TR 800 ms, TE 21 ms, 28 ms, 14 ms, 21 ms), and in the FSE T2 sequence in the transverse plane (TR 3000 ms, TE 120 ms). Based on the results of the

Fig 1. Dorsoventral X-ray of right hip joint in cat. Radiograph revealed a large radiolucent area in the proximal femoral epiphysis *(arrow head),* surface remodeling of the femoral head and subcartilaginous sclerotization

Fig 2. Dorsoventral X-ray of right hip joint in cat. The femoral head contains radiolucent foci *(arrow head)*

MRI exam, a decision was made to perform resection arthroplasty of the right femoral head. General anesthesia was maintained by inhalation of 1-2% isoflurane (Aerane, Baxter Polska, Warszawa, 100%) with fentanyl (Fentanyl WZF, Polfa, Warszawa, 50 µg/mL) administered by constant rate infusion (CRI) at 10 µg/kg/h with an infusion pump. Vital signs were monitored throughout the procedure. Arthroplasty of the right hip joint was performed in the lateral approach. The articular capsule was opened, the separated epiphysis was removed and the femoral neck was resected with a bone saw. Cephalosporin (Cefalexim,

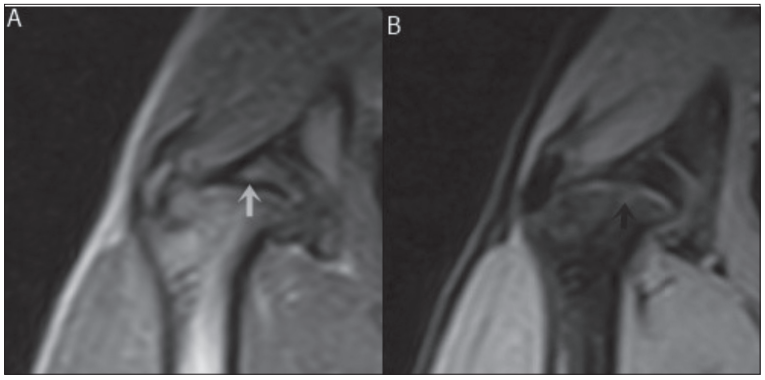

Fig 3. Dorsal plane of the left hip joint in a cat in: A) SE T1 sequence, B) XBONE sequence – water-only image. A hypointense signal in the site of growth plate widening is marked with a *white arrow.* A hyperintense signal indicative of bone marrow edema in a fat-suppressed sequence is marked with a *black arrow*

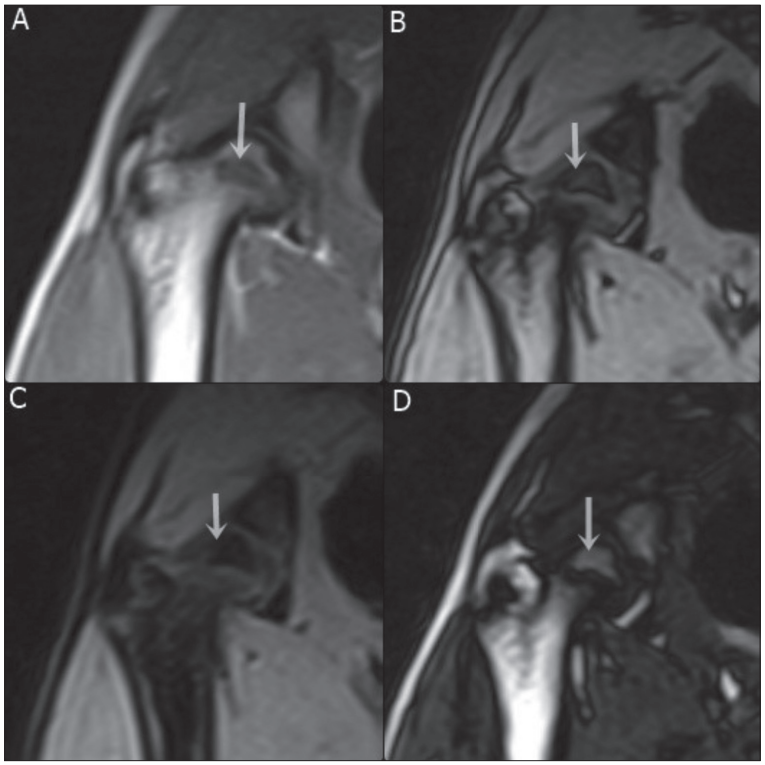

Fig 4. Dorsal plane of the left hip joint in a cat in: A) SE sequence, B) GE sequence, C) XBONE sequence - fat-only image, D) XBONE sequence - water-only image. *Arrows* indicate hypointense foci in SE and GE sequences and the fat-only image, and hyperintense foci in a fat-suppressed sequence in the femoral head which are indicative of a subchondral cyst

ScanVet Poland, Warszawa, 180 mg/1 mL) at 10 mg/kg IV and meloxicam (Metacam, Boehringer Ingelheim Vetmedica, 20 mg/mL) at 0.2 mg/kg SC were administered preoperatively, and injections were continued for 4 days. The resected femoral head was placed in 10% formalin solution and subjected to a histopathological analysis. The histopathological examination revealed uneven surface of the epiphyseal plate with multifocal cartilage lesions, proliferation of fibrous connective tissue and bone tissue, and cartilaginous metaplasia with the accumulation of chondroblasts, osteoblasts and osteoclasts. The owner has been informed about necessity of X-ray control of the left hind limb after one month, but he disagreed for any further treatment, due to non-visible symptoms of lameness in left limb.

The MRI examination of hip joints revealed pathological changes in the right and left limb. T1 hypointense widening of the growth plate and a hyperintense signal in the XBONE sequence in the "water-only" image which is characteristic of bone marrow edema were noted in the left limb *(Fig. 3)*. An oval-shaped change measuring 8 mm x 4 mm x 3 mm in the left femoral neck produced a hypointense signal in SE T1 and XBONE sequences (in GE and "fat-only" images) *(Fig. 4)*. A hyperintense signal in the region of the described change was obtained in the "water-only" image in XBONE and FSE T2 sequences. The characteristic of signal changes suggested the presence of subchondral cysts. In the right limb, the femoral head was clearly separated from the neck, and a hematoma was detected between the separated fragments based on a signal with varied intensity and foci of high signal intensity in fat-suppressed SE T1 and FSE 2 sequences and a hypointense signal in a water-suppressed sequence *(Fig. 5)*. Minor hypointense foci indicative of fibrous tissue proliferation was observed in the region of the separated femoral head in SE T1 and FSE T2 sequences. A hyperintense signal characteristic of bone marrow edema was also noted in the "water-only" image in the XBONE sequence.

DISCUSSION

Magnetic resonance imaging is not a specific test for diagnosing slipped capital femoral epiphysis, but it is helpful in evaluating the accompanying complications such as chondrolysis or osteonecrosis [11]. There is only one published report on the use of MRI for diagnosing slipped capital femoral epiphysis in cats, but the obtained images were not described [1]. The changes that accompany non-traumatic separation of capital femoral epiphysis have also been studied in pigs and dogs [12] In the MRI exam, the above changes were identified as minor hypointense foci in the femoral head in SE T1 and FSE T2 sequences. The femoral head was completely separated in the right limb. In the discussed case, a hematoma was detected between the slipped capital femoral epiphysis and the femoral neck. The MRI signal of a hematoma is determined by the breakdown products of hemoglobin [13], and it varies in different stages of hematoma organization. Initially, high oxyhemoglobin content generates a high-intensity signal in fat-suppressed T2-weighted sequences and a low-intensity signal in T1-weighted sequences. Deoxyhemoglobin is produced

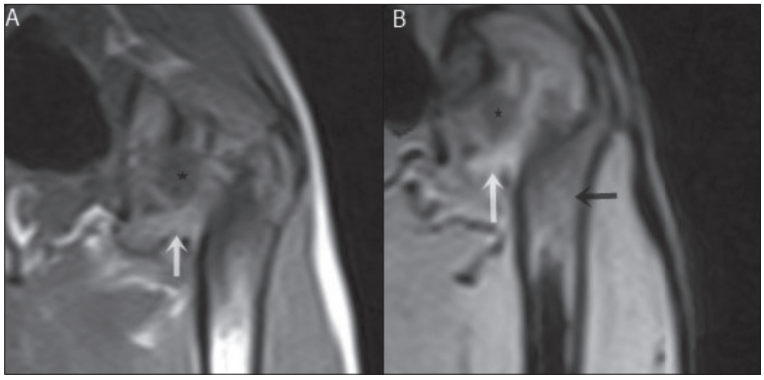

Fig 5. Dorsal plane of the right hip joint in a cat in: A) SE T1 sequence, B) XBONE sequence - water-only image. A hyperintense signal in the site of the hematoma is marked with a *white arrow.* A hyperintense signal indicative of bone marrow edema in a fat-suppressed sequence is marked with a *black arrow.* A hypointense signal indicating the loss of cartilaginous tissue and proliferation of fibrous tissue in the femoral head is marked with an *asterisk*

approximately one h after hematoma formation, and it produces a hypointense signal in T2-weighted images. After 24 h, intracellular methemoglobin appears as a hyperintense mass in T1-weighted images. Erythrocytes are decomposed one week after hematoma formation, and they release methemoglobin which increases signal intensity in T1- and T2-weighted images. In the last stage, hemosiderin-laden macrophages accumulate at the periphery of the hematoma and decrease signal intensity in all sequences [14]. A varied signal with hyperintense foci generated by methemoglobin in SE T1 and FSE T2 sequences is indicative of hematoma organization, and it suggests that the hematoma was formed more than 24 h ago. On the radiograph of the right limb the femoral head was clearly separated from the neck and MRI was performed for confirming the diagnosis. The hematoma formation and bone marrow edema were not visible on the X-ray.

Growth plate widening and a regular area on the femoral neck with a signal characteristic of fluid components were noted in the left limb. Oval or round areas characterized by low-intensity signals in T1-weighted images and high-intensity signals in T2-weighted images can suggest the presence of subchondral cysts [15]. In the absence of complete separation and dislocation of the femoral head, the above changes could be indicative of the onset of slipped capital femoral epiphysis [11,16]. The changes in the growth plate of the left leg observed in MRI scans were not visualized in radiographs. MRI detected early physeal changes of onset slipped capital femoral epiphysis when X-rays were normal. MRI can revelated early bone marrow edema and growth plate widening, which can be not visible on X-ray. Magnetic resonance imaging is a useful tool for detecting SCFE in contralateral asymptomatic hip.

MRI scans supported the visualization of pathological changes in both pelvic limbs of the evaluated cat. Growth plate widening, bone marrow edema and the presence of a subcartilaginous cyst were indicative of the onset of slipped capital femoral epiphysis in the left limb. Complete separation of the femoral head, the presence of a hematoma and bone marrow edema in the right limb were indicative of advanced progression of the disease in the right limb. MRI scans supported the identification of changes that were not visualized in radiographs, which facilitated prognosis and the choice of the appropriate treatment.

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