

# Case report: Proximal Femoral Physeal Dysplasia in a Cat and a Review of the Literature

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## ABSTRACT

Femoral physeal dysplasia is a condition in cats resulting in unilateral or bilateral separation of the femoral head from the femoral neck along an abnormal physis. Physeal dysplasia in cats has not been extensively described in veterinary literature, but a review of published data has revealed that while neither the complete pathogenesis nor the incidence is well known, it is suggested that male gender, neutered status, and obesity are contributing factors. A change in castration age could serve as a preventive measure for feline patients. Radiographs have been demonstrated to be the method of diagnosis of choice and surgical correction is the treatment of choice, with a femoral head and neck ostectomy being the most commonly performed procedure. Further study of the condition would be useful to determine predisposing conditions and possible preventive measures.

**Keywords:** feline, physis, dysplasia, femur, review.

## CASE REPORT

A 27 month-old, castrated, male domestic short hair cat was presented with acute onset of non-weight-bearing right pelvic limb lameness of four hours duration. The cat was kept indoors and had no history of trauma. Pain was elicited on manipulation of the right pelvic limb. At first the lameness appeared to be centered at the tarsus; radiographs of the right tarsus were acquired and were normal.

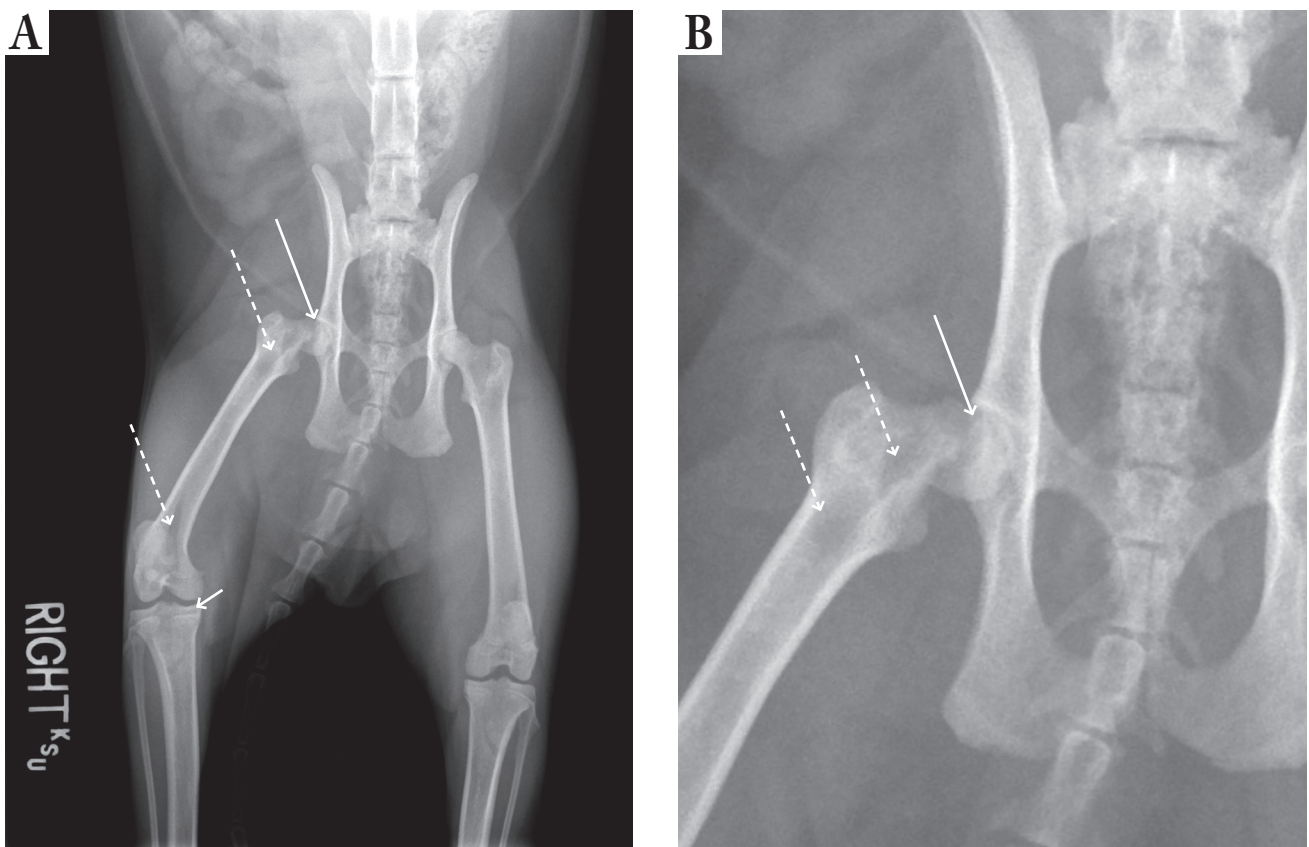
A complete blood count (CBC) and serum biochemistry revealed hyperglycemia (glucose 276 mg/dL (reference range 63-140 mg/dL)) with a primary differential of stress, hypokalemia (potassium 3.2 mmol/L (reference range 3.3 – 5.2 mmol/L)) with a primary differential of anorexia of short duration due to pain, and increased creatinine kinase activity (836 U/L (reference range 71-502 U/L)) with a primary differential of muscle damage. Weight at presentation was 5.6 kg.

Because the tarsal joint was normal on radiographs taken

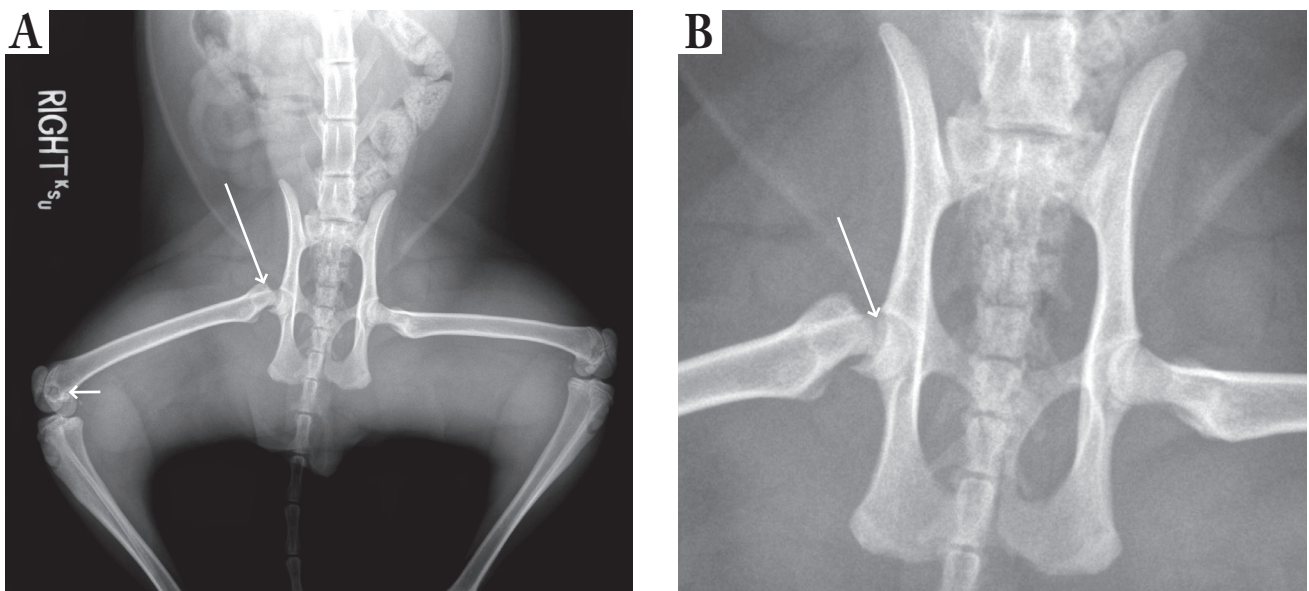
at presentation and the cat continued to be painful, pelvic and femoral radiographs were acquired.

Radiographic evaluation documented a fracture through the proximal right femoral physis. The femoral head (epiphysis) remained within the acetabulum and there was mild cranial and dorsal displacement of the rounded femoral neck. The distal femoral and proximal tibial physes were open. Radiographic diagnosis of proximal physeal fracture of the right femur consistent with physeal dysplasia and delayed physeal closure was made. Ventrodorsal view radiographs with abduction was acquired (Figures 1 and 2) for more complete evaluation and better assessment of the opposite limb. No abnormalities of the left proximal femur were present.

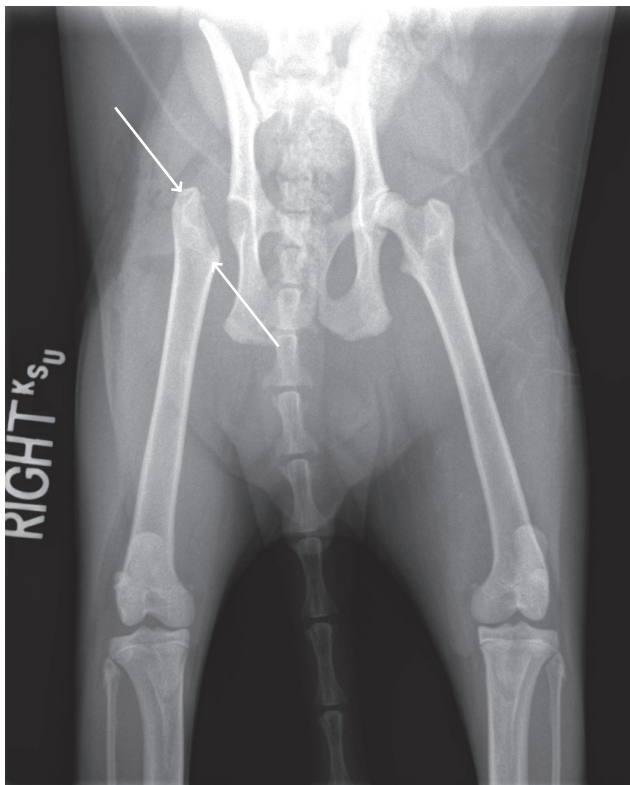
A femoral head and neck ostectomy was performed on the right pelvic limb. On post-operative radiographs, the greater and lesser trochanters were preserved (Figure 3).



**Figure 1:** Original (A) and magnified (B) extended leg ventrodorsal radiographs of the pelvis. There is radiolucency in the right femoral neck and the distal femur (dotted arrows), and proximal tibial physes are open (arrow head). The femoral head remains within the acetabulum (solid arrow) and there is a proximal physal fracture evidenced by step malalignment between the femoral head and neck.



**Figure 2:** Original (A) and magnified (B) dorsoventral radiographs of the pelvis with pelvic limb abduction. The right femoral neck is rounded and radiolucent. A fracture is present through the right proximal femoral physis (arrows), and there is cranial displacement. The right distal femoral and proximal tibial physes remain open (arrowheads).



**Figure 3:** Extended ventrodorsal view. The head and femoral neck of the right femur have been removed by Femoral Head and neck Ostectomy (FHO) preserving the greater and lesser trochanters of the femur (arrows). A small bone fragment remains medial to the greater trochanter. Soft tissue gas is present lateral to the right proximal femur.

## DISCUSSION

Normal closure times for femoral capital, distal femoral and proximal tibial physes are 30-44 weeks, 54-76 weeks and 50-76 weeks respectively (1). At the time of diagnosis the cat in this study was 108 weeks old; well beyond the time of normal physeal closure.

Lesions similar to those described in this study have been described previously in young cats and have been compared to slipped capital femoral epiphysis in humans (2-6). Radiographs from previous studies have described areas of radiolucency and loss of definition as well as lysis, sclerosis and resorption in the femoral neck of the affected limb (4, 6). Salter-Harris type I fractures have been most commonly described in previous studies with varying displacement of the epiphysis and femoral neck (5). Affected cats are frequently adolescent to adult, overweight, castrated males with delayed physeal closure. These cats typically present as bilateral or unilateral fractures of the capital physes of the femur and often no traumatic incident has been witnessed. (Table 1).

A previous study has demonstrated that a multicentric disorder of the chondrocytes precedes the development of slipped capital femoral epiphysis (7). Histopathologically, commonly found abnormalities include a physeal width more than twice that of normal cat femoral physes, an irregular chondrocyte organization in place of the typical linear arrangement, and a zone of chondronecrosis that when evaluated after chronic change had developed granulation tissue and early callus formation (8). This condition, termed physeal dysplasia in cats, may result in either a slipped capital femoral epiphysis or a fracture of the femoral neck. Either condition may occur in the absence of history of trauma. The result is a unilateral or bilateral separation of the femoral head from the femoral neck along an abnormal physis. The ventrodorsal view with abduction was acquired to aid in determining that there was no fracture of the opposite limb.

The reported cases of femoral neck fracture and capital physeal separation appear to all have a similar presentation. The majority of affected cats are young, obese, male cats. Of the cats where age of neutering was reported, those that presented for femoral fractures were castrated at a young age. Delayed physeal closure has been associated with early castration, perhaps increasing the likelihood of fracture with trauma (4). No history of trauma was reported for the cat in this study or for cats reported in previous studies (Table 1). In relation to the apparent predisposition of this disease process to male castrated cats before physeal closure (7-9 months), if we assume that this disease should be distributed evenly among male and female cats, the data from those identified as intact or gonadectomized based on a  $\chi^2$  test indicates that neutered males are predisposed compared to ovariectomized females ( $p < 0.0005$ ) (1, 4, 5-7, 12, 17). However, the true worth of this is difficult to assess because while the affect of testosterone on physeal closure has been proven, there are broad age ranges in the current literature, up to 24 months in multiple studies when physes should be closed, and gonad status for a large number of animals is not identified (9).

The data available in the literature also implies that overweight cats are predisposed to femoral physeal dysplasia with an average weight of 5.9 kg. This is supported in the canine literature that indicates an increase in total body weight predisposes dogs to secondary changes in joints and prolonged epiphyseal plate maturation (10).

There are few reports of physeal dysplasia in the veterinary literature. The syndrome has not been extensively stud-

**Table 1:** Comparison of data from femoral physeal dysplasia cases previously reported.

Authors	Breed	Sex	Age Neutered (months)	Age at presentation (months)	Weight at presentation (kg)	Unilateral or Bilateral	Treatment
Longley and Marshall (2013) <sup>17</sup>	British Shorthair	MC	Not reported	18	Not reported	Bilateral	FHO
Ridge (2006) <sup>12</sup>	1 British Blue	MC	6	24	5.2	Bilateral	FHO
Newton and Craig (2006) <sup>7</sup>	2 DSH	2 MC	Not reported	48	5.6	Bilateral	Conservatively, then elective euthanasia.
			Not reported	Adult	3.6	Unilateral	Euthanized due to lymphosarcoma.
Burke (2003) <sup>16</sup>	1 DSH	M	At time of FHO	14	4.4	Unilateral	All FHO
McNicholas et al. (2002) <sup>4</sup>	22 DSH	25 MC	8 at <4m	Mean 22.5±6.5	Mean 5.6±1.2	5 Bilateral	24 FHO
	3 Maine Coon	1 FS	6 at 4-6m	Range 12-42	Range 3.4-7.4	21 Unilateral	1 k-wire
	1 Siamese cross		2 at 6-8m				1 conservative
Craig (2001) <sup>2</sup>	10 DSH	10 MC	Not reported	Average 16.3 Range 4.5-24	Average 5.6	5 Bilateral	Not reported
	3 Siamese	1 F				6 Unilateral	
		1 FS				2 Not Available	
		1 M					
Queen et al. (1998) <sup>6</sup>	12 DSH	15 MC	Not reported	Range 5-24	Not reported	4 Bilateral	FHO
	1 Siamese	2 M				13 Unilateral*	
	1 Siamese cross						
	1 British Blue						
	1 Birman						
	1 Shorthair colour point						
Pérez-Aparicio and Fjeld (1993) <sup>5</sup>	61 Norwegian crossbred	21 F#	Not reported	Median 5 Range 2-36	Not reported	2 Bilateral <sup>s</sup>	Not reported.
		39 M#				60 Unilateral	
	1 Burmese	2 unknown					

MC = Male, castrated; M = intact male; FS = female, spayed; F = intact female, DSH = Domestic Short Hair, FHO = Femoral head and neck osteotomy.

\* 5 became bilateral within 5 months of initial presentation.

# Castrated versus intact not reported.

<sup>s</sup> This study differentiated between femoral neck fractures and capital epiphyseal separation. One cat had bilateral femoral neck fractures and one cat had both femoral neck fracture and capital physeal separation. All other cats had unilateral disease.

Data collected from the literature relating to physeal dysplasia in cats. Males were generally over-represented, although age of neutering was not reported in 6 of the nine cited manuscripts. The majority was unilateral (102/121) and managed surgically with FHO. While return to function was not objectively monitored, there were reports of subjective improvement after the pseudoarthrosis has formed (12, 16, 17).

ied and the exact pathogenesis is unknown. Several theories have been suggested including insufficient arterial supply to the femoral head, osteomyelitis of bacterial origin, high energy feeds and abnormal insulin metabolism (11, 12). It has been suggested that feline physeal dysplasia is similar to slipped capital femoral epiphysis (SCFE) in humans (2). Humans with SCFE typically present as overweight, male adolescents with no history of trauma (11, 13). An autosomal dominant inheritance pattern with variable penetrance has been suggested in humans (13). Because plain radiography is often diagnostic in human patients and the affect-

ed femoral head is rarely excised the exact pathogenesis of the human disease is not known, however it has been noted that a SCFE does not have the marked chronic degenerative change with mineral opacity that is classic in physeal dysplastic fractures (13, 14). However, the human condition has been suggested to be due to infarction and avascular necrosis of non-inflammatory origins of the femoral epiphysis (6). The epiphyseal blood supply is more easily damaged and the metaphyseal blood supply is more readily revascularized during repair causing pathology to be primarily in the epiphyseal region (15).



Physeal dysplasia in cats has been compared to Legg-Calve-Perthes disease of dogs. Arterial supply to the femoral head in the cat is a combination of intra-osseous vessels from the nutrient artery to the metaphysis, direct arterial penetration of the metaphysis and epiphysis and arterial supply to the epiphysis from the artery of the teres ligament (6). Arterial supply to the teres ligament has been described as "poor" in dogs as well as children, perhaps contributing to the development of this disease in canine and human patients rather than feline patients (15). Legg-Calve-Perthes disease has been reported in the cat and cow, however, no further reports have been made, and the exact radiographic lesions of canine patients differ from those described in the feline patient (6).

Osteomyelitis of bacterial origin or endocrinological abnormalities, such as with insulin metabolism, have also been suggested as contributing factors in the development of physeal dysplasia. Metaphyseal bone necrosis has been experimentally induced in the cat via intravenous inoculation of feline herpes virus (6).

High energy feeds in horses have been linked to osteochondrosis due to altered chondrocyte maturation caused by increased circulating levels of insulin and it has been suggested that this may also apply to cats with physeal dysplasia (8). It has also been proposed that insulin metabolism defects, such as a receptor defect, and a lack of necessary growth factors could lead to the persistence of a disorganized physis that remains open due to improperly differentiated chondrocytes (2).

Reports, which included data regarding treatment, demonstrate acceptable return to function following femoral head and neck excision (FHO) including cats with bilateral disease (4, 5, 6, 7, 16). This is perhaps due to the low body weight of cats and a lack of need for athletic performance in cats as a factor in determining treatment success.

## CONCLUSION

Physeal dysplasia is a condition in cats resulting in unilateral or bilateral separation of the femoral head from the femoral neck along an abnormal physis. Physeal dysplasia in cats has not been extensively described in veterinary literature. Neither the complete pathogenesis nor the incidence is well known. It has been suggested that male gender, neutered status, and obesity are contributing factors. A change in cas-

tration age could serve as a preventive measure for feline patients. Radiographs have been demonstrated to be the method of diagnosis of choice and surgical correction is the treatment of choice. Further study of the condition would be useful to determine predisposing conditions and possible preventive measures.

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