

# Retrospective Analysis of Extra-Pelvic Injuries Verified at the First Admission of Cats With Pelvic Fractures

## Key words

extra-pelvic;  
injury;  
trauma;  
skeleton

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**Abstract:** This retrospective study aimed to identify the common extra-pelvic injuries at the first admission at the hospital of cats with pelvic fractures. The medical records and radiographs were assessed. Seventy-three cats with pelvic fractures were identified, of which 41 were associated with extra-pelvic injuries. Of the 41 animals with extra-pelvic injuries, 21 were females and 20 were males. Motor vehicle trauma represented 56.09% of the pelvic fracture cause. Injuries to the appendicular skeleton included femur (n=12), tibia (n=1), lateral malleolus (n=1) and olecranon (n=1) fractures, and unilateral hip luxation (n=4). In the axial skeleton, mandibular condyle fracture (n=1), fracture of lumbar vertebrae (n=1), fracture and/or luxation of the coccygeal vertebrae (n=3), and luxation between S3 and the first coccygeal vertebra (n=3) were detected. Sacrum or sacroiliac fractures were detected in six cases. Sacroiliac luxation was verified in 22 cats unilaterally (n=15) and bilaterally (n=7). Respiratory tract lesions were pulmonary contusion (n=2), pneumothorax (n=2), and diaphragmatic hernia (n=1). Lesions of the urinary system organs included bladder rupture (n=3) and bladder entrapment in the hernia (n=1). In the integumentary system, there was one case of cutaneous laceration and one of subcutaneous emphysema. Traumatic hernias of the abdominal wall were found in five cats. Nervous system lesions included traumatic brain injury (n=2) and spinal cord injury (n=1). Two cats presented with constipation. Two animals died, and two were euthanized due to the severity of the injuries. In conclusion, the extra-pelvic injuries at admission were more frequent in the appendicular skeleton, mainly represented by femur fractures.

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## Introduction

Anatomically, the bony pelvis is constituted of the os coxae, which include the ilium, ischium, and pubis; the sacrum; and the first coccygeal vertebra (1, 2). The acetabulum, ilium, and sacroiliac joint are considered weight-bearing structures of the pelvis (1, 3). Including all trauma-induced fractures verified in the small animal practice it has been reported that pelvic fractures correspond to around 20-25% of those that occur in cats (2-5). The causes of pelvic fractures in cats include motor vehicle trauma or falls from heights, but there are reports of kicking and crushing injuries (3, 4).

Because the pelvic bones are protected by surrounding musculature, major trauma is needed to induce fractures in these bones, which also promotes extra-pelvic injuries (1). Consequently, various body systems may be affected in cats with pelvic fractures. These may include fractures of long bones, fracture/luxation of the sacroiliac joint, hip luxation, and herniation, among others (1, 4, 6, 7). For example, in a study of 108 fractures in cats detected over one year, 73% had hind limb involvement, and 22% included the pelvis/sacrum (8). In addition, a retrospective study of 280 cats with pelvic fractures observed involvement of the abdomen

(57.5%), thorax (49.6%), soft tissue (48.6%), nervous system (43.6%), extremities (25.4%), and face (13.9%) (9).

Since the evaluation should not be limited to the pelvis and immediate surrounding areas but the entire patient (4, 10), this retrospective study aimed to identify the principal extra-pelvic injuries verified at the first hospital admission of cats with pelvic fractures.

## Materials and methods

This study was approved by the Institutional Ethics Committee for the Use of Animals (CEUA - no. 059/2020).

The medical records and radiographs of domestic cats with pelvic fractures examined at a veterinary teaching hospital were retrospectively assessed for a 6-year period. Data analysis included only those cats with extra-pelvic injuries concomitant to pelvic fractures verified at the first admission. Patient signalment (sex, breed, age, body mass), fracture cause, and types of extra-pelvic injuries (appendicular and/or axial skeleton and other body systems) were obtained. Radiographs of the pelvic fractures were classified (11) as follows: sacroiliac fracture/luxation, ilial wing fracture, fracture of the body of the ilium, acetabular fracture, ischial and/or tuber ischium fracture, and pelvic floor fracture. Unassisted death and euthanasia were also assessed.

## Results

Seventy-three cats with pelvic fractures were identified, of which 41 were associated with extra-pelvic injuries (Table 1). Of the 41 animals with extra-pelvic injuries, 21 were females and 20 were males. Except for two Siamese cats, all the others were mixed breeds. Age ranged from 2.0 months to 15 years (mean of 25.72 months  $\pm$  40.49). Eight cats were classified as adults based on radiographs as age information was not available. The body mass ranged from 0.8 kg to 4.8 kg (mean of 2.8 kg  $\pm$  1.66), with one animal lacking this information.

Causes of pelvic fractures included motor vehicle trauma (56.09%; 23/41), dog bite (7.31%; 3/41), and domestic accidents (7.31%; 3/41), including trapping in a motor vehicle, falling from a height, and tile falling on the body. A total of 17.07% (7/41) of the cats lived indoors but escaped from home and returned injured. The history was not provided for 12.19% (5/41) of the cases. Twenty cases showed extra pelvic lesions exclusively in the skeletal system, 17 in other body systems, and four included the skeletal and other body systems.

Injuries to the appendicular skeleton included femur (n=12), tibia/lateral malleolus (n=2) and olecranon (n=1) fractures, and unilateral hip luxation (n=4). Femoral head was displaced

into the pelvic canal because of the acetabular fracture in two cases (nos. 11 and 41). In the axial skeleton, mandibular condyle fracture (n=1), fracture of lumbar vertebrae (n=1), fracture and/or luxation of the coccygeal vertebrae (n=3), and luxation between S3 and the first coccygeal vertebra (Cd1) (n=3) were detected. Sacrum or sacroiliac fractures were observed in six cases. Sacroiliac luxation was verified in 22 cats unilaterally (right side, n=8; left side, n=7) and bilaterally (n=7). In addition, there were cats with traumatic brain injury (n=2) and spinal cord injury (n=1).

Respiratory tract lesions were pulmonary contusion (n=2), pneumothorax (n=2), and diaphragmatic hernia (n=1). Lesions of the urinary system organs included bladder rupture (n=3) and bladder entrapment in the hernia (n=1). In the integumentary system, there was one case of cutaneous laceration and one of subcutaneous emphysema. Traumatic hernias of the abdominal wall were found in five cats. Two cats presented constipation at admission.

Two animals died (nos. 26 and 41), and two were euthanized (nos. 21 and 38) due to the severity of the pelvic injuries, respectively associated with pulmonary contusion, constipation, L6 fracture, and brain injury/bladder rupture.

The individualized or combined site of the pelvic fracture in the 41 cats were as follow: ilial body (14.63%, n=6); ilial body and pelvic floor (7.31%, n=3); ilial body, pelvic floor and ischium/tuber ischium (14.63%, n=6); ilial body, pelvic floor and acetabulum (4.87%, n=2); ilial body and sacrum (2.43%, n=1); pelvic floor (4.87%, n=2); pelvic floor and sacrum (2.43%, n=1); pelvic floor and ischium/tuber ischium (24.39%, n=10); pelvic floor, ischium/tuber ischium and sacrum (4.87%, n=2); ischium/tuber ischium (7.31%, n=3); tuber ischium and sacrum (2.43%, n=1); acetabulum (4.87%, n=2); acetabulum and sacrum (2.43%, n=1); acetabulum and ischium (2.43%, n=1).

The pelvic floor fracture had an occurrence of 63.41% (26/41), followed by ischial/tuber ischium fracture (53.65%; 22/41), ilial body fracture (43.90%; 18/41), sacrum fracture (14.63%; 6/41), and acetabular fracture (14.63%; 6/41). Table 1 shows cats' signalment, fracture cause, extra-pelvic injuries, and site of the fracture/luxation.

## Discussion

The present study evaluated extra-pelvic injuries at first admission in domestic cats with pelvic fractures and verified their occurrence in 56.16% (41/73) of cases. The proportion was lower than in a study of cats with pelvic fractures in which 93.6% (262/280) had an additional injury established by body regions, of which 82.1% were due to road traffic accidents and 10.4% high-rise syndrome (9). Although vehicular trauma was the most frequent cause in both studies, the high-rise syndrome characterized by

**Table 1:** Signalment (sex, breed, age, body mass) of 41 cats with extra-pelvic injuries resulting from pelvic fractures, including fracture cause and site of the fracture/luxation.

No.	Breed	Sex	Age	Body Mass	Cause	Extra-pelvic lesion	Fracture/luxation sites
1	mixed	F	6 mo.	1.8 kg	Motor vehicle trauma	Mid-diaphyseal, long oblique right femoral fracture	Bilateral ilial body fracture
2	mixed	F	6 mo.	1.4 kg	Trapping in a motor vehicle	Mid-diaphyseal, comminuted right femoral fracture (open)	Right ilial body fracture
3	mixed	M	2 yr.	4 kg	Motor vehicle trauma	Mid-diaphyseal, comminuted right femoral fracture	Bilateral pelvic floor fracture; Right sacrum fracture
4	mixed	F	1 yr.	4.7 kg	Motor vehicle trauma	Left distal femoral fracture (Salter Harris type II).	Right ischial fracture
5	mixed	F	4 mo.	2.2 kg	Motor vehicle trauma	Right distal femoral fracture (Salter Harris type I).	Left ilial body fracture, Left pelvic floor fracture, Left acetabular fracture; Right sacroiliac luxation S3–Cd1 luxation
6	mixed	M	4 mo.	2.4 kg	Motor vehicle trauma	Left proximal femoral physeal fracture	Bilateral pelvic floor fracture, Right ischial fracture; Bilateral sacroiliac luxation; Sacrum luxation (S2-S3)
7	Siamese	M	6 mo.	2.3 kg	Motor vehicle trauma	Right proximal femoral physeal fracture	Right acetabular fracture; Sacrum luxation (S1-S2, S2-S3)
8	mixed	M	6 mo.	2.5 kg	Motor vehicle trauma	Right proximal femoral physeal fracture	Right ilial body fracture S3–Cd1 luxation
9	mixed	M	1 yr.	3.8 kg	Escaped	Left proximal femoral physeal fracture	Right pelvic floor fracture, Right ischial fracture, Bilateral tuber ischium fracture
10	mixed	F	2.6 mo.	0.8 kg	Motor vehicle trauma	Right proximal femoral physeal fracture	Right pelvic floor fracture, Left sacroiliac luxation
11	mixed	M	11 mo.	2.3 kg	Escaped	Long oblique fracture of distal third of right tibia-fibula Right hip luxation	Left ilial body fracture, Bilateral pelvic floor fracture, Right acetabular fracture; Left sacroiliac luxation
12	mixed	M	1 yr.	3.8 kg	Escaped	Fracture of the left condylar process of the mandible Left ocular proptosis	Left ilial body fracture, Left pelvic floor fracture; Right sacroiliac luxation
13	mixed	F	6 mo.	2.3 kg	-	Left lateral malleolus fracture	Right ilial body fracture, Right pelvic floor fracture, Left ischial fracture
14	Siamese	F	Adult	3.7 kg	Motor vehicle trauma	Left hip luxation	Left pelvic floor fracture, Left ischial fracture
15	mixed	M	5 mo.	3.3 kg	Motor vehicle trauma	Right hip luxation	Left tuber ischium fracture; Bilateral sacroiliac luxation
16	mixed	F	4 yr.	4.8 kg	Motor vehicle trauma	Right hip luxation	Ilial body fracture; S3–Cd1 luxation
17	mixed	F	3 mo.	1.3 kg	Falling	L7-S1 subluxation, Cd6-Cd7 subluxation, Cd9 Fracture	Avulsion of the left tuber ischium; Bilateral sacroiliac luxation; Sacrum fracture (S2), S2-S3 subluxation
18	mixed	F	8 mo.	2.9 kg	-	Co1-Co2 subluxation	Right pelvic floor fracture, Right ischial fracture Left sacroiliac luxation
19	mixed	F	2 mo.	1.1 kg	Dog bite	Co6-Co7 luxation	Right acetabular fracture, Right ischial fracture Left sacroiliac luxation
20	mixed	F	1.5 yr.	3.7 kg	Motor vehicle trauma	L7-S1 articular process luxation	Left ilial body fracture
21	mixed	M	Adult	3.5 kg	Motor vehicle trauma	L6 vertebral body fracture	Bilateral pelvic floor fracture, Left ischial fracture; Bilateral sacroiliac luxation
22	mixed	F	6 mo.	2.5 kg	Motor vehicle trauma	Diaphragmatic hernia	Bilateral pelvic floor fracture, Avulsion of tuber ischium
23	mixed	M	3 yr.	3.8 kg	Escaped	Right hind limb proprioceptive deficit	Bilateral pelvic floor fracture; Right sacroiliac fracture/luxation, Left sacroiliac luxation

24	mixed	M	6 mo.	4.5 kg	Dog bite	Pulmonary contusion; Subcutaneous emphysema	Left acetabular fracture
25	mixed	M	Adult	5.2 kg	-	Bladder entrapment in the inguinal hernia	Bilateral pelvic floor fracture; Bilateral sacroiliac luxation
26	mixed	F	7 mo.	2.2 kg	Motor vehicle trauma	Pulmonary contusion Left proximal femoral physal fracture	Bilateral pelvic floor fracture, Right ischial fracture; Right sacroiliac luxation
27	mixed	F	11 yr.	2.1 kg	Escaped	Pneumothorax Olecranon fracture	Left ilial body fracture, Left pelvic floor fracture, Left ischial fracture; Right sacroiliac luxation
28	mixed	M	Adult	4.4 kg	Motor vehicle trauma	Pneumothorax	Right ilial body fracture, Bilateral pelvic floor fracture, Right ischial fracture
29	mixed	F	10 yr.	4.5 kg	Motor vehicle trauma	Bladder rupture	Right ilial body fracture, Right pelvic floor fracture, Right ischial fracture
30	mixed	M	Adult	3.2 kg	Motor vehicle trauma	Traumatic brain injury	Left ilial body fracture, Right sacroiliac luxation
31	mixed	M	Adult	3.6 kg	Tile falling on the body	Spinal cord injury	Left tuber ischium fracture
32	mixed	M	2 mo.	1 kg	Motor vehicle trauma	Cutaneous laceration in the tail and right pelvic limb.	Left ilial wing and body fracture, Bilateral pelvic floor fracture, Bilateral tuber ischium fracture; Right sacroiliac luxation
33	mixed	F	4 yr.	3 kg	Motor vehicle trauma	Traumatic abdominal wall hernia	Bilateral pelvic floor fracture, Right ischial fracture; Bilateral sacroiliac luxation
34	mixed	F	7 mo.	2.6 kg	Motor vehicle trauma	Traumatic abdominal wall hernia	Left pelvic floor fracture, Avulsion of the right tuber ischium; Sacrum fracture (S2), S2-S3 subluxation
35	mixed	M	6 mo.	2 kg	-	Traumatic abdominal wall hernia Left proximal femoral physal fracture	Left ilial body fracture, Bilateral pelvic floor fracture, Left tuber ischium fracture; Left sacroiliac luxation
36	mixed	F	Adult	4 kg	Escaped	Traumatic abdominal wall hernia	Right ilial body fracture; Sacrum fracture (S1-S2); Left sacroiliac luxation.
37	mixed	M	adult	3.6 kg	Motor vehicle trauma	Traumatic abdominal wall hernia	Left ilial body fracture, Bilateral pelvic floor fracture
38	mixed	F	15 yr.	-	Motor vehicle trauma	Traumatic brain injury Bladder rupture	Left ilial body fracture, Left pelvic floor fracture; Right sacroiliac luxation
39	mixed	M	2 yr.	3.3 kg	Escaped	Bladder rupture	Left pelvic floor fracture, Left ischial fracture; Right sacroiliac luxation
40	mixed	F	4 yr.	2.8 kg	-	Constipation	Left pelvic floor fracture, Left ischial fracture
41	mixed	M	3 mo.	2.1 kg	Dog bite	Pelvic narrowing, constipation	Left acetabular fracture; Sacrum fracture/luxation (S1-S2); Bilateral sacroiliac luxation

falling from buildings was not verified in the current study, reflecting differences in environmental factors.

There were 36.58% (15/41) of cats with long bone fractures in this study, of which 29.26% (n=12) were in the femur. However, only two femoral fractures had a comminuted pattern. In a study with 103 cats, the type of pelvic fracture was not associated with the severity of femoral fracture (n=13), being most diaphyseal and comminute (6). The fact suggests that the mechanism of femoral injury was potentially more severe in those cases than in ours. On the other hand, this same study verified fractures involving the growth plate of the femoral head in cats with a mean

age of 6.6 months (6). Similarly, cats with proximal femoral physal fractures (n=7) in the present study had a mean age of 6.22 months, indicating a young population exposed to the same risk.

Pelvic fracture accompanied by sacroiliac luxation was noted in 53.65% of patients (22/41), 63.63% unilateral (n=14) and 36.36% (n=8) bilateral. The sacroiliac luxation should be treated surgically in bilateral injuries, with severe displacement or neurological deficits, among others (1). One study found that 65% (11/17) of cats had uni or bilateral sacroiliac subluxations concurrent with sacral fractures that were attributed to a possible weak attachment of the

pelvis to the vertebral column in the species (12). Sacrum or sacroiliac fractures were detected in 14.63% of the animals (6/41). The sacroiliac luxations or fractures may cause instability, pain, and neurologic lesion (5). An association between sacral body fracture and ischial body fracture was described in a study (6), but this association was not found in the present study.

Hip luxation was verified in 9.75% of the cats (4/41), two young cats and two adults, and only one related to acetabular fracture. In another study, both hip luxation and comminuted fracture of the femoral neck were found in cats with pelvic fractures and a mean age of 39.3 months (6). The presence of hip luxation makes the treatment method for pelvic fracture more complex (3).

Despite reports that sciatic nerve dysfunction can be detected in 11% of cats with pelvic fractures (1), only one cat showed a sensory deficit in one pelvic limb (2.43%) associated with sacroiliac fracture/luxation and bilateral pelvic floor fracture. Peripheral nerve injury was described in 11 cats related to sacroiliac fracture-dislocation, as verified in the present study, or may be due to the ilial fracture as described in the literature (13). In addition, an association between sciatic nerve injury and ipsilateral iliac body fracture has been reported (6).

Thoracic trauma can also occur in cats with pelvic fractures (1, 5) that promote injuries, such as pulmonary contusions, pneumothorax, hemothorax, rib fractures, and diaphragm rupture, among others (11). In the present study, 12.19% (5/41) of cats showed thoracic trauma, including diaphragmatic hernia, pneumothorax, and pulmonary contusion, most resulting from a car accident. The diagnosis and initial management of these injuries are fundamental due to the potential to become life-threatening (1, 14).

Concerning urinary tract injury, one incarcerated bladder and three bladder ruptures were observed. All cases of bladder ruptures were associated with concomitant pelvic floor fractures, which corresponded to 11.53% of all pelvic fractures. The bladder is one of the organs most damaged combined with pelvic fractures, which may be related to penetrating trauma from a fracture fragment or a full bladder being pressed or ruptured by blunt trauma (4, 7, 10). In addition to bladder rupture, ureteral avulsion, urethral laceration, and kidney injury have also been reported (1, 11), but these were not identified in the current study. The uroabdomen is classified as a medical emergency, and surgical repair of the lesion should be performed once the animal is stable (15).

Five (12.19%) traumatic hernias of the abdominal wall were detected in the present study. In addition to herniation, there are reports of rectum laceration and rupture of the pre-pubic tendon (3, 7) that were not observed in the current study. Obstipation and constipation are generally

considered late complications, with a high risk in cases of severe pelvic narrowing (10, 11). Constipation was verified in two cats, probably related to the type of pelvic fracture and associated injuries, but also due to the time interval between the injury and admission to the hospital.

Euthanasia was done in two cats, one due to a spinal fracture and the other with traumatic brain injury and bladder rupture. A retrospective study of 208 cats with pelvic fractures observed a higher mortality rate in cases of neurological injuries or bilateral involvement of the weight-bearing axis (9). Acute death because of pelvic fractures is uncommon in cats, but mortality and morbidity associated with injuries can occur (10). In the current study, there were two deaths at presentation, one cat had a pulmonary contusion caused by a car accident, and the other had a sacral fracture and constipation due to a dog bite.

The highest number of fractures occurred in the pelvic floor (63.41%, n=26), followed by the ischial and/or tuber ischium fracture (53.65%, n=22) and the ilial body (43.90%, n=18). These findings differed from a study with 103 pelvic fractures, in which 90% of cats had fractures involving the pelvic floor, followed by ilial body fractures (48.5%) and ischial body fracture or avulsion of the tuber ischium (26%) (6). Since the ilial body is included in the weight-bearing structures of the pelvis, surgical management must be considered (1, 3).

Acetabular fractures accounted for 14.63% (n=6) of the lesions. The acetabulum is also a weight-bearing segment of the pelvis and must be reconstructed if fractures occur in its central and caudal areas (1, 3). In a study with 103 cats, 17.5% (n=18) had acetabular fractures. In general, the impact drives the femoral head into the acetabulum, with consequent acetabular fracture, which may be associated with ilium and pubis fractures (5). A severe lesion was observed in two cases (4.87%) because of the femoral head displacement into the pelvic canal.

The most frequent fracture combinations were pelvic floor and ischial/tuber ischium fracture (24.39%, n=10), followed by the ilial body, pelvic floor, and ischial fracture/avulsion of the tuber ischium (14.63%, n=6). The findings differed from another study in which the most frequent combination was the pelvic floor and ilial body fractures (6), suggesting different effects of trauma events on populations.

In conclusion, the extra-pelvic injuries at the first admission of cats with pelvic fractures were more frequent in the appendicular skeleton, mainly represented by femur fractures. Other lesions, such as in the respiratory or urinary systems, were in fewer numbers but represented potentially life-threatening conditions.

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## Retrospektivna analiza poškodb izven medenice, potrjenih ob prvem sprejemu mačk z zlomom medenice

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**Izveček:** Namen te retrospektivne študije je bil ugotoviti pogoste zunajmedenične poškodbe ob prvem sprejemu mačk z zlomom medenice v bolnišnico. Pregledali smo medicinsko dokumentacijo in rentgenske slike. Identificirali smo 73 mačk z zlomom medenice, od katerih jih je bilo 41 povezanih z zunajmedeničnimi s poškodbami. Od 41 živali z zunajmedeničnimi poškodbami je bilo 21 samic in 20 samcev. Poškodbe zaradi motornih vozil so predstavljale 56,09 % vzrokov zlomov medenice. Poškodbe privesnega skeleta so vključevale zlom stegenice ( $n = 12$ ), golenice ( $n = 1$ ), lateralnega skočnega sklepa ( $n = 1$ ) in olekranona ( $n = 1$ ) ter enostranski izpah kolka ( $n = 4$ ). V osnem skeletu so bili odkriti zlom čeljustnega kondila ( $n = 1$ ), zlom ledvenih vretenc ( $n = 1$ ), zlom in/ali izpah repnih vretenc ( $n = 3$ ) ter izpah med S3 in prvim repnim vretencem ( $n = 3$ ). V šestih primerih so bili ugotovljeni zlomi križnice ali križnice in črevnice. Izpah križnično-črevničnega sklepa je bil potrjen pri 22 mačkah, enostransko ( $n = 15$ ) ali obojestransko ( $n = 7$ ). Poškodbe dihalnih poti so vključevale kontuzijo pljuč ( $n = 2$ ), pnevmotoraks ( $n = 2$ ) in diafragmalno hernijo ( $n = 1$ ). Poškodbe organov sečil so vključevale rupturo mehurja ( $n = 3$ ) in ujetje mehurja v hernijo ( $n = 1$ ). Najden je bil en primer raztrganine kože in en primer podkožnega emfizema. Travmatske hernije trebušne stene so bile ugotovljene pri petih mačkah. Poškodbe živčnega sistema so vključevale travmatsko poškodbo možganov ( $n = 2$ ) in poškodbo hrbtenjače ( $n = 1$ ). Dve mački sta imeli zaprtje. Dve živali sta poginili, dve sta bili zaradi resnosti poškodb evtanazirani. Zaključimo lahko, da so bile zunajmedenične poškodbe ob sprejemu pogostejše na privesnem skeletu, ki so jih predstavljali predvsem zlomi stegenice.

**Ključne besede:** zunajmedenični; poškodba; travma; skelet