

Cause and clinical characteristics of rib fractures in cats: 33 cases (2000–2009)

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Abstract

Objective – To characterize the clinical features and population differences among cats sustaining traumatic and nontraumatic rib fractures.

Design – Retrospective clinical study.

Setting – University small animal hospital.

Animals – Thirty-three cats with radiographic evidence of rib fractures.

Interventions – None.

Measurements and Main Results – Cats with rib fractures were identified by performing a computer search of the radiology database. Thirty-three cats that sustained rib fractures were identified between January 2000 and September 2009. Seventeen cats had fractures due to trauma and 16 were deemed to occur from nontraumatic causes. A Mann-Whitney rank-sum test revealed statistically significant differences in the median ages between the 2 groups. Older cats were more likely to sustain rib fractures as a result of a presumed nontraumatic causes. A Chi-square analysis showed that nontraumatic fractures occurred significantly more often in the midbody region and involved the 9th–13th ribs. The majority of cats with presumed nontraumatic rib fracture had respiratory disease; the remaining cats had chronic renal disease or neoplasia. Cats with traumatic rib fractures had external signs of trauma.

Conclusion – Rib fractures in cats may be clearly associated with trauma, or may be an incidental finding in cats with comorbidities. Cats with diseases that cause prolonged respiratory effort or coughing, metabolic diseases, or certain neoplasms, are at increased risk of spontaneous nontraumatic rib fractures.

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Introduction

Rib fractures can be classified either traumatic or nontraumatic in origin, with trauma considered to be the most common etiology in animals. Trauma may result from blunt or penetrating injury, while nontraumatic fractures can be benign or malignant. Causes of benign nontraumatic fractures include metabolic bone disease, osteogenesis imperfecta, and 'stress' fractures associ-

ated with abnormalities of the thoracic bellows, such as in severe airway disease.^{1–4} Nontraumatic rib fractures may also be due to primary, multicentric or metastatic neoplasia.

The anatomic shape and relative resiliency of the feline thorax decrease the propensity for traumatic rib fracture.^{5,6} In 1 study 25% of dogs sustaining other bony fractures due to a motor vehicle accident had concurrent rib fractures, while in a similar study in cats, only 1.6% were found to have rib fractures.^{7,8}

Recognition of the etiology of rib fractures is essential for the emergency and critical care clinician as traumatic rib fractures are markers for significant thoracic injury which often requires aggressive supportive care, and nontraumatic fractures could mislead a clinician into pursuing a traumatic etiology rather than investigating naturally occurring thoracic disease.

The goals of this study were to characterize clinical and population features of cats with traumatic rib

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fractures compared with those with nontraumatic rib fractures.

Materials and Methods

Criteria for selection of cases

Cats were identified for inclusion into the study by performing a search of the radiology report database. All cats with radiographic evidence of rib or sternum fractures evaluated at the Foster Hospital for Small Animals, Cummings School of Veterinary Medicine between January 2000 and September 2009 were eligible for study inclusion.

Procedures

A standardized data collection sheet was used to record information from the medical record including signalment, presenting complaint, concurrent clinical findings, and outcome. Rib fractures were classified as traumatic or nontraumatic based upon a review of the medical record including owner history, past medical history including environment, and presenting complaint. Trauma cases were considered those with witnessed trauma, or history and physical examination consistent with trauma, such as the presence of multiple injuries in cats with access to the outdoors. Fractures were classified as nontraumatic in cats without a history of trauma, external wounds, regular access to the outdoors, and the absence of another medical condition. Information was recorded as to the number of fractures present, the nature of the fracture (old/healing or new), and location. Healing was defined as the radiographic presence of a callus. Location was classified according to the rib number, side of the thoracic cavity (left or right), and location on the rib, which was defined as ventral/sternal, midbody, or dorsal/spine. Nontraumatic fractures were further classified according to the suspected associated underlying cardiopulmonary disease, neoplastic or metabolic disease.

Statistics

Descriptive statistics were used to characterize the groups evaluated. Statistical tests were performed with computer software.^a Nonparametric data were compared using a Mann-Whitney rank-sum test, with a *P* value of <0.05 considered significant. Correlation between number of fractures and location of rib fractures and outcome (survival) was calculated. Chi-square analysis was used to compare rib fracture location and perceived cause of fracture.⁹

Results

Thirty-three cats that met the study inclusion criteria were identified. Seventeen cats had rib fractures due to trauma, and 16 cats had rib fractures without a history of trauma. Ninety-three rib fractures were identified in total; 54 were secondary to trauma and 44 were assessed as nontraumatic in origin.

Cats with a traumatic etiology of rib fractures were all domestic short- and long-haired cats, including 12 castrated males, 2 spayed females, 1 intact male, and 2 cats with the sex not recorded. The median age was 3 years (range 6 mo to 11 y). Trauma was due to motor vehicular trauma (*n* = 9), bite wounds (*n* = 2), fall (*n* = 1), and unknown cause of trauma (*n* = 5). All 5 cats with unknown trauma had other injuries that were considered consistent with traumatic injury. No cat had injuries thought to be associated with animal abuse. Concurrent thoracic traumatic injuries documented in affected cats included pulmonary contusions (*n* = 14; 82%), subcutaneous emphysema affecting the fractured hemithorax (*n* = 8; 47%), pneumothorax (*n* = 7; 41%), and radiographically detectable pleural effusion, assumed to be hemorrhage (*n* = 6; 35%). No cat had a flail chest identified. Eleven cats survived to discharge, 3 cats died and 3 were euthanized. Record review supported that no cat died or was euthanized due specifically to the rib fractures or any pulmonary or pleural complication, but rather from the extent of concurrent injuries, including hind limb paralysis, severe brain injury, and sepsis. All traumatic rib fractures were deemed to be new in nature. Ten of 17 cats had multiple rib fractures and 7 of 10 cats had single rib fractures. Forty-eight percent of traumatic rib fractures were localized to the dorsal/spine segment, 48% were in the midbody and 4% were in the sternal segment. Number of rib fractures or rib fracture location was not associated with outcome.

There were 16 cats with rib fractures that were not associated with a witnessed or suspected trauma. The median age was 13 years (1–16 y), which was significantly older than cats with traumatic rib fractures (*P* = 0.001). There were 10 domestic short-haired cats, and 1 of each of the following breeds: domestic long hair, Showshoe, Persian, 1 Himalayan, Singapura, and Chartreux. Three cats had upper respiratory disease; 1 with a laryngeal mass, 1 with a tracheal mass, and 1 with chronic nasal disease. No cat had evidence of a hiatal hernia, which has previously been associated with nontraumatic fractures.³ Four cats each had lower airway disease and pleural effusion. One cat had metastatic plasma cell tumor with multiple pathologic fractures. In 4 cases, there was no historical evidence of trauma and no history of respiratory distress or disease.

Three of these cats had chronic renal failure, and 1 cat had an osteolytic mass on the left hind extremity. In the cats with chronic renal failure, there was no apparent change in bony density visible on radiographs.

Three cats were euthanized, and the remaining 13 were discharged. Euthanasia was performed due to diagnosis of neoplasia ($n = 2$) and progressive renal failure in 1 cat. The rib fractures were not considered a proximate cause of euthanasia in any cat.

The rib fractures were assessed as healing due to the presence of visible callus in 10 cats, and of unknown chronicity (no callus) in 6 cats. It was suspected that these 6 cats with no evidence of callus formation had acute nontraumatic fractures. Six cats had a single rib fracture; the remaining 10 cats had multiple fractures. Cats with lower airway disease had a single fracture of the 13th rib ($n = 2$), a single fracture of the 10th rib ($n = 1$), and fractures of the 10th–12th ribs in the final case (Figure 1).

Nontraumatic rib fractures were located in the midbody of the rib in 85% of the fractures, which was significantly different than the distribution in traumatic fractures, where more fractures were found near the spine ($P = 0.0003$).

In evaluating fractures of the 9th–13th ribs, cats with trauma had these ribs affected in 46% of cases, while in cats with suspected nontraumatic fractures, these caudal ribs were fractured 88% of the time ($P < 0.0001$).

Discussion

This study documents the characteristics of rib fractures in cats and describes those cats with known trauma history and those without suspected trauma. Traumatic rib fractures result from direct force or com-

pression of the ribs beyond the ability of the rib to deform.^{4,8} Not surprisingly, the median age of cats sustaining traumatic rib fractures was 3 years, which is consistent with previous studies.⁴ Vehicular trauma accounted for the majority of cats with known trauma. Diagnosis was straightforward, and therapy was supportive as well as specific based on the extend of the other injuries. A previous study identifying 75 cats with traumatic rib fractures found similar patient characteristics, and a similarly favorable outcome.⁴

In the population of cats that presented without known trauma, the etiology is more difficult to determine. A prior unknown trauma is difficult to rule out but was not noted in any of the animal's histories nor did physical examination document any other evidence of trauma. In infants, rib fractures can also be challenging to identify the exact cause, with differentials including child abuse, bone fragility disorders, and accidental (including birth) trauma.¹⁰ Bulloch *et al*¹⁰ noted that traumatic fractures in infants were often associated with severe witnessed trauma, as was seen in cats in the present study. In that study, nontraumatic fractures were associated with bone disease, and differentiation was completed by a review of the medical records.¹⁰ Coughing in association with pneumonia has been associated with rib fractures in infants as well.¹¹ Radiographs are considered insensitive for detection of small rib fractures, and bone scans are the test of choice.^{11,12} However, scintigraphy is not widely available in companion animal practice. Ultrasonography has also been described in foals as a viable technique, but had not been similarly applied to cats.¹³

Cats with a suspected nontraumatic cause were significantly older, with a median age of 13 years. The majority of cats without a trauma history had primary respiratory or cardiac disease, and the remainder had chronic renal disease or neoplasia. These disease processes more often affect older animals.

The location of rib fractures, both in the chest and on the rib, was more variable in cats with known trauma than in those without. With traumatic injury this is not a surprising finding as location would reflect variability in the point of impact. In contrast, in cats without known trauma, the fractures are more commonly located in the more caudal aspect of in the rib cage, and at the midbody of the rib. The location of the caudal aspect of the rib cage agrees with a prior study evaluating stress fractures in dogs and cats, however, location along the rib body was more variable.³ This is the location that is subject to the highest forces associated with respiration, as force generated is proportional to distance displaced. The biomechanical forces of the rib cage have been well described.¹⁴ During respiration, the inspiratory muscles contract, pulling the ribs

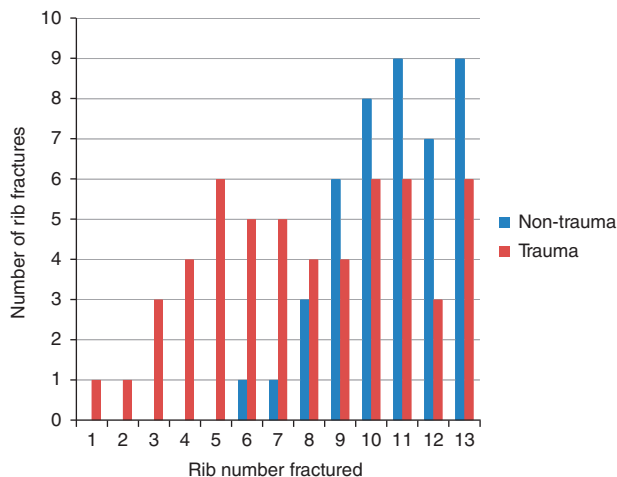


Figure 1: Graph specifying the ribs fractured (rib number) and the frequency each rib number was fractured.

outward and forward, resulting in widening and shortening of the rib cage. Expiration is passive in healthy animals, but may be active with airway disease (eg, chronic bronchitis/asthma). The force and work required for inspiration is related to the elastic resistance of the lungs and chest wall.¹⁴

In people, stress fractures of the ribs have been reported in association with cough and with activities such as rowing.¹⁵ Fractures were seen primarily in those with chronic cough; women more so than in men.¹⁶ Fractures were most often located in the middle 1/3 of the rib, in the 5th–9th ribs.¹⁶ Bending forces are thought to contribute to these fractures and the middle 1/3 of the rib is subject to the greatest forces.¹⁶ The anterior serratus and external abdominal oblique muscles insert on the ribs and it is postulated that repetitive mechanical stress, chronic microtrauma, bone remodeling, and muscle fatigue contribute to fracture.^{16,17}

In this study, 85% of cats sustaining nontraumatic rib fractures had fracture sites located in the midbody region and 88% of the fractures were in the 9th–13th ribs. The location along the midbody region may be due to similar bending forces on this part of the rib. Cats more frequently had the caudal ribs affected compared with distal ribs in people and this may be due to the differing stance. Because of quadrupedal motion, the cranial part of the rib cage experiences less movement during respiration than the caudal ribs allowing for more rigid construction of the muscles of the forelimbs and a more stable stance.^{18,19}

Eleven of the 16 cats without known trauma had respiratory or thoracic diseases that were chronic in nature. Four cats had lower airway disease and chronic cough. Respiratory diseases such as asthma, bronchitis, postnasal drip, and pneumonia are more commonly associated with stress fractures in people.¹⁶ One cat had nasal discharge and sneezing. Sneezing has been associated with rib fractures in people with the mechanism being similar to that of coughing.²⁰ Two cats had masses that obstructed the upper airway. To the authors' knowledge, no cases of rib fracture associated with inspiratory stridor have been reported in the human literature. One cat in a previous study developed rib fractures postulated to be secondary to repeated upper airway obstructions.³ Four cats had pleural effusion. There have been cases of rib fracture associated with pleural effusion in people, but the cause of the fracture is thought to be due to underlying disease's effect on thoracic wall dynamics rather than the effusion itself.¹¹ Heart failure, neoplasia, abscess formation within the lungs were the causes of the effusions in these cases. Each case was associated with chronic, increased respiratory rate and effort. Prolonged, increased effort leads to increased work of breathing which can cause increased mechan-

ical stress and muscle fatigue both of which are thought to contribute to rib fracture.

Additionally, there are some differences in the cat chest wall as compared with people and dogs. The shape of the feline chest is more conical with the diameter increasing distally to a much greater degree than both dogs and people.¹⁹ Low movement occurs in the cranial ribs in both dogs and cats. In cats, the strongest rib movement occurs in the caudal ribs until the 12th rib; the 13th rib still has a moderate amount, which is different from other species.¹⁹ If the caudal ribs are involved in the strongest respiratory excursions, than they would be subjected to a greater mechanical stress.

Three of 16 cats with nontraumatic rib fracture had chronic kidney disease. Secondary renal hyperparathyroidism and renal osteodystrophy are well-documented effects of chronic renal disease.^{21,22} Pathologic fractures and decreased bone density are common in people with end stage kidney disease.²² Phosphorus retention, reduced calcitriol synthesis, and reduced blood-ionized calcium concentrations contribute to increased circulating levels of PTH. This results in increased bone resorption and fibrosis. Additionally, decreased calcitriol results in reduced enteric absorption of calcium resulting in impaired mineralization of osteoid and a rickets-like osteomalacia.²³ Skeletal abnormalities or fracture associated with renal osteodystrophy are infrequently reported in dogs and rarely reported in cats.^{23,24}

One cat believed to have a nontraumatic rib fracture had a plasma cell tumor. Plasma cell tumors can invade bones; particularly those involved in hematopoiesis and can result in lytic lesions, diffuse osteoporosis, and pathologic fracture. Twenty-five to 30% of dogs with multiple myeloma have radiographic evidence of bony involvement.²⁵ Skeletal lesions from plasma cell tumors are rare in cats, occurring in 8% of cases in 1 report.²⁶

Ten of 16 cats with nontraumatic rib fractures had fractures that were radiographically assessed to be healing. In people sustaining stress fractures, the most common presenting sign is an acute onset of chest pain.²⁰ The fact that these fractures were not diagnosed when they occurred may suggest that these cats did not display pain or were not perceived to be painful. Since many of these cats had respiratory disease, whether or not they had worsening of their signs at the time of fracture is unknown. Clinical signs associated with rib fractures in cats may be subtle and overlooked as part of respiratory disease. However, rib fractures are considered painful, and pain assessment is a vital part of therapy in cats.

Limitations to this study included its retrospective nature and small sample size. Additionally, rib fractures may be subtle and may have been overlooked on thoracic imaging particularly if only 1 view was taken,

and thus those cats were not included in this study. Additionally, while rib fractures were present, in no case did they clearly affect outcome and thus the relevance of rib fracture in cats may be less important than in other species.

In conclusion, rib fractures occur infrequently in cats, but rib fractures from nontraumatic causes apparently appear with a similar frequency as traumatic rib fracture. These cats are generally older and have diseases that make them more susceptible to fracture. The incidental finding of rib fractures, particularly when noted in the 9th–13th ribs, should not be assumed to be from a prior trauma, but rather should prompt further consideration for a different underlying cause. Additionally, increased awareness of the potential for rib fractures in cats with predisposing diseases may help guide appropriate diagnostic and therapeutic strategies.

Footnote

^a SPSS 15 for Windows, SPSS Inc, Chicago, IL.

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