Vet. Med. Austria / Wien. Tierärztl. Mschr. **93** (2006), 295 - 299

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Imaging diagnosis and successful management of a spinal cord injury following a dog bite in a cat

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received July 17, 2006
accepted for publication October 23, 2006

Keywords: cat, vertebral impression fracture, spinal compression, dog bite.

Summary

An 8 month-old, male, European Short Hair cat was presented with signs of a grade III spinal compressive lesion (paraparesis, not able to walk) located in the thoracolumbar spine following a dog bite. After cardiovascular stabilisation of the patient, diagnostic imaging including plain radiographs and computed tomography (CT) were undertaken. CT revealed an impression fracture of the bodies of the first and second lumbar vertebrae with compression of the spinal cord by the fragments. Treatment consisted of surgical exploration of the bite wound via a lateral approach, decompression of the spinal cord and cage rest for 4 weeks.

The cat regained full neurological function within 1 week of surgery and is still free of any clinical signs 12 months later.

Computed tomographic examination strongly helped to precisely define the type and extent of the bony and concurrent soft tissue lesion which was very difficult to assess with plain radiography. The technique is fast, non-invasive and accurate, thus helping to minimize surgical trauma and patient morbidity.

Schlüsselwörter: Katze, Wirbelimpressionsfraktur, spinale Kompression, Bissverletzung.

Zusammenfassung

Diagnose und erfolgreiche chirurgische Therapie einer Wirbelimpressionsfraktur infolge einer Bissverletzung bei einer Katze mittels computertomographischer Untersuchung

Ein 8monatiger Europäisch Kurzhaarkater wurde mit Lähmungserscheinungen der Hinterextremitäten nach einer Bissverletzung im Lumbalbereich vorgestellt. Die eindeutige Diagnose einer Wirbelimpressionsfraktur des ersten und zweiten Lendenwirbelkörpers mit Verdrängung des Rückenmarkes konnte mit Hilfe einer computertomographischen Untersuchung gestellt werden. Die Therapie bestand aus einer Dekompression des Myelons durch die Entfernung der Frakturfragmente mittels eines lateralen Zugangs. Eine nachfolgende Stabilisierung schien aufgrund der Biomechanik der Fraktur nicht notwendig. Es konnte eine vollständige Wiederherstellung der neurologischen Funktion erreicht werden.

Abbreviations: ALT = alanine aminotransferase; CT = computed tomography; GLDH = glutamate dehydrogenase; MCH = mean corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration; MRI = magnetic resonance imaging

Introduction

Animal interaction is one of the most common causes of feline trauma in urban regions (KOLATA et al., 1974; KOLATA, 1980) leading to multiple organ injuries. However, few studies report vertebral injuries as a sequel mainly in small dogs (THIESS, 1983; LORINSON, 1993; SOMMER, 1998), whereas to the authors' knowledge there is no report of such an injury in a cat.

In the case of vertebral trauma, a thorough neurological exam to establish a neuroanatomical localisation is the veterinarian's most important diagnostic tool. This should be followed by survey radiographs which can give an overview of static lesions. However, the definite extent of spinal injury is often difficult to determine from plain ventrodorsal and laterolateral radiographs. Multiple views ideally taken under heavy sedation or anaesthesia are often necessary, but advanced diagnostic techniques like myelography, computed tomography (CT) or magnetic resonance imaging (MRI) are needed to establish spinal compression and to ensure that additional lesions not seen on survey radiography are not present (BAGLEY, 2000). CT helps to detect the presence of bony fragments within the vertebral canal as well as articular facet fractures and allows fracture stability to be assessed. We describe a case in which CT was a valuable tool for the accurate determination of the lesion. Therefore, surgical trauma and patient morbidity could be significantly reduced. Removal of bone fragments and subsequent decompression of the spinal cord without additional stabilisation of the involved vertebrae led to complete recovery of neurological function.

Case Report

An 8 month-old male European Short Hair cat was presented 2 hours after a dog bite. Ever since the trauma the cat had not been able to walk. The cat was in lateral recumbency, had weak femoral pulses with a rate of 200/min and pale mucous membranes. The inner body temperature of 34.5 °C and lung sounds were decreased. A skin and muscle laceration of 1x2 cm was noted on the left flank, crepitation on the right forearm was present, and the left upper canine tooth was fractured. Initial therapy consisted of rapid fluid resuscitation with lactated Ringer's solution at a

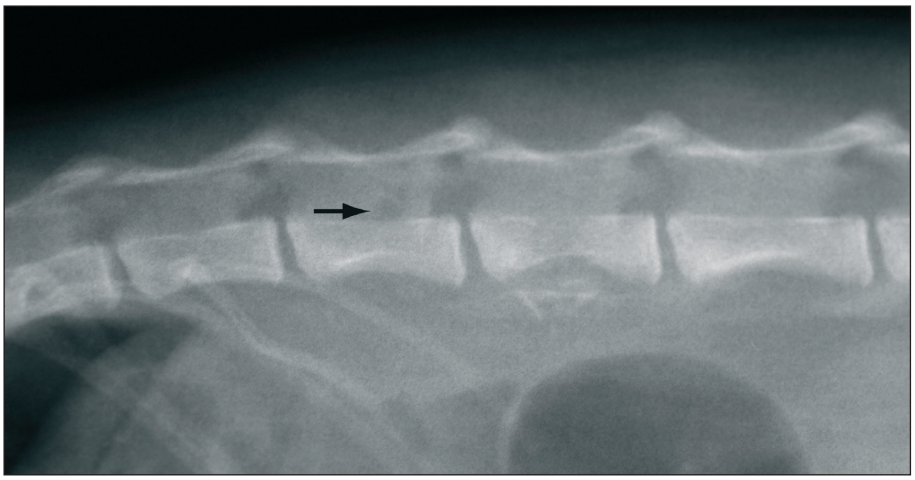

Fig. 1: Radiograph of the cranial lumbar spine in right lateral recumbency; the mid portion of the 2nd vertebral body shows a radiolucent area, its transverse process cannot clearly be defined and there are several bony fragments visible within the soft tissue density of the lumbar muscles. There is a focal radiolucent area at the level of the caudal vertebral canal of L1 (arrow). Adjacent to latter there are small areas of increased density. The left 13th rib is fractured.

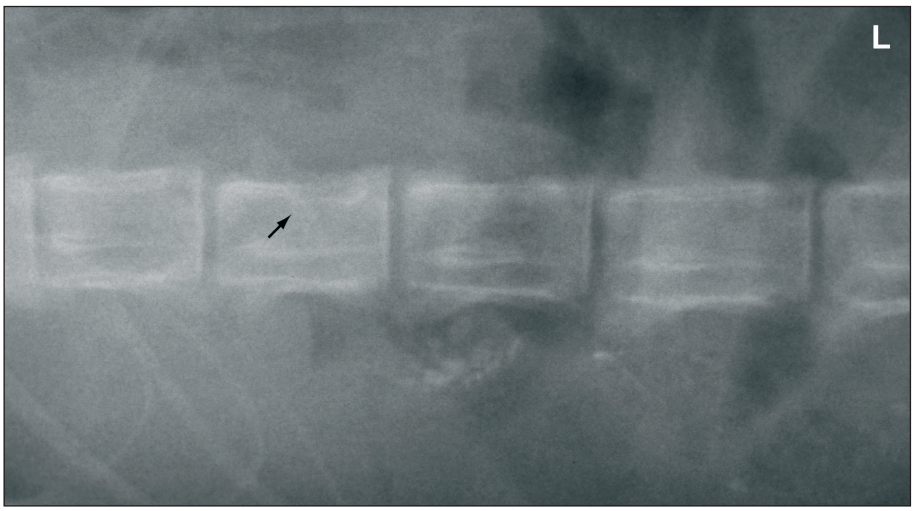

Fig. 2: Ventrodorsal view of the cranial lumbar spine; the caudal contour of the vertebral arch of L1 is ill defined with slightly decreased density and a triangular calcified structure superimposed on the vertebral body paramedian to the spinal process (arrow). Otherwise there are no abnormalities.

rate of 10 ml/kg/h and hydroxyl ethyl starch solution (HES 130/0.4) 6 % (Free flex Voluven Infusionslösung®, Fresenius Kabi, Graz), analgesia with methadone (Heptadon®, Ebewe Pharma, Unterach) 0.1 mg/kg and a transdermal fentanyl patch (Durogesic 25 µg-Depot-Pflaster®, Janssen-Cilag Pharma, Wien), and amoxicillin/clavulanic acid (Clavamox intravenös 550 mg®, Sandoz, Kundl) 20 mg/kg twice daily. Routine blood examination consisted of a haemogram, measurement of blood glucose, serum creatinine, total protein, alkaline phosphatase, alanine aminotransferase, glutamate dehydrogenase, and serum potassium levels; the results are listed in Tab. 1. After the cat had regained cardiovascular stability a complete neurological exam was performed. The cat showed absent conscious proprioception and normal spinal reflexes, superficial pain perception was absent and deep pain perception was present on both hind limbs, respectively. The findings were consistent with a lesion of the spinal cord grade III (SCOTT, 1997; SCOTT and McKEE, 1999) between the third thoracic and the third lumbar vertebral segment.

Thoracic radiographs in left lateral and dorsoventral recumbency revealed a mild amount of free air within the right hemithorax and little subcutaneous gas bilaterally. Lung transparency was slightly decreased and lung pattern was interstitial which was probably due to lung contusion. The left 13th rib showed 2 transverse fractures with slight dislocation. 2 areas of increased density approximately 3 mm in size with a slightly radiolucent area in between could be seen at the level of the caudal spinal canal of the first lumbar vertebra (Fig. 1) and the radiographs also showed bony fragments of 4 to 5 mm in diameter ventrally to the second lumbar vertebra. The vertebral body itself had a decreased density in its mid portion. The left transverse process could not be clearly identified. On the ventrodorsal view the left vertebral arch and the facet joints of L1 were decreased in density and could not be exactly delineated (Fig. 2). Radiographs of the right forelimb revealed a transverse fracture of the distal radius, the ulna was intact.

Since vertebral fractures were suspected, CT was performed for a more accurate determination of the lesions. The cat was premedicated with midazolam 0.15 mg/kg (Midazolam "Nycomed" 5 mg/ml-Ampullen®, Nycomed Austria, Wien) and ketamine 2 mg/kg (Ketasol Injektionslösung®, Schöller Chemie, Wien). Anaesthesia was induced with 5 mg propofol (Propofol® 1%, Fresenius, Graz) and maintained with isoflurane (Forane®, Abbott, Wien) in oxygen. Transverse single slice CT images with slice thickness and separation of 1 mm revealed a fracture of the lamina of L1 with at least 2 fragments being dislocated into the vertebral canal, thus compressing the spinal cord and dislocating it dorsally and to the right (Fig. 3). The facet joints

Tab. 1: Values of haematology and blood chemistry

Parameter	Value	Range	Parameter	Value	Range
erythrocytes	5.58 x 10^6/µl	5.50 - 10.00	glucose	86 mg/dl	55 - 100
haemoglobin	7.7 g/dl	8.0 - 17.0	creatinine	0.80 mg/dl	< 1.60
haematokrit	22.0 %	27.00 - 47.00	total protein	5.11 g/dl	6.00 - 7.5
mean corpuscular volume	39.4 fl	40.0 - 55.0	alkaline phosphatase	47 mmol/L	< 30
MCH	13.8 pg	13.0 - 17.0	ALT	1,165 mmol/L	<100
MCHC	35.0 %	31.0 - 34.0	GLDH	20.85 mmol/L	<10.0
leukocytes	10,920.0/µL	6,000-18,000	potassium	3.6 mmol/L	3.5 - 5.0

and the vertebral body were intact. The body of L2 showed a comminuted sagittal paramedian fracture of its mid portion, without loss of the dorsal vertebral body cortex (Fig. 4). Fragments were displaced ventrally.

Following the CT examination, surgical exploration of L1 and L2 was done. The cat was placed in lateral recumbency, a lateral approach was chosen to approximate the lesion (SEEMAN, 1968; FLO and BRINKER, 1975) and 3 fracture fragments of the body of L1 inside the vertebral canal compressing the spinal cord evenly from ventrolateral were found. They could be retrieved by gentle manipulation and levering, leaving macroscopically intact nervous tissue and dura mater. Fracture fragments originating from L2 did not interfere with the vertebral canal, they were left with their muscular attachments in the surrounding tissue. Since the articular facets of both vertebrae were intact, no further stabilisation was performed. Devitalized tissue around the laceration was excised and the wound was closed routinely. The fracture of the right radius was reduced and treated conservatively with a splinted bandage. The cat recovered from anaesthesia uneventfully.

An indwelling urinary catheter was used to facilitate bladder voiding for 24 hours. After that time the cat was able to urinate by itself and the catheter was removed. The physical exam 18 hours later showed improvement of the neurologic status: the cat was able to stand with assistance and showed good muscle tone in both hind legs. Conscious proprioception was still decreased, spinal reflexes and deep pain perception were normal. 2 days postoperatively the cat was able to walk by itself. A new transdermal fentanyl patch was applied on day 4. The cat was discharged from the hospital one week later and maintained in cage rest for an additional 24 days. After that time the cat was still kept indoors and restricted to one room without the possibility to perform high jumps for 3 weeks. The splinted bandage was changed every 10 days until 6 weeks after the accident. At that time the fracture was clinically stable, no lameness was recorded and radiographs showed bridging callus formation. The cat was clinically normal 12 months later.

Discussion

In the current case, diagnosis of the extent of the vertebral fracture was only accurate after CT imaging. Plain radiographs are generally taken as soon after the injury as the overall condition of the animal allows. They provide a first idea of the extent of the trauma and the anticipated prognosis. For more detailed information several additional techniques are available, including myelography, CT and MRI.

Computed tomography is especially indicated to assess bony details and spatial alterations. Soft tissues can usually be better evaluated with the help of MRI than with CT, but the use of iodinated contrast material in the CT often enables the surgeon to gain sufficient information. It is particularly important to appreciate compression of the spinal cord and stability of a fracture to decide if the patient is a surgical candidate. Non-surgical treatment can be considered if only minimal compression of the spinal cord is present and the lesion is in a location amenable to splinting, for example the cervical region (SHARP and WHEELER, 2005). Cases with affection of the thoracic or lumbar spine, are preferredly treated surgically as are those with unstable fractures or luxations and conditions that compress the spinal cord. In our cat we found distinct displacement and compression of the spinal cord to the right and dorsally (Fig. 3) due to a piece of lamellar bone originating from the left lamina of L1 protruding into the vertebral canal. Here CT proved to be highly valuable, since only minimal alterations can be seen on plain radiographs at the level of L1.

Judgement of fracture stability can be done preoperatively from knowledge of the elements of the vertebral column that are compromised. We used a method described by SHARP and WHEELER (2005), which is a modification of a simple classification into ventral and dorsal compartments by SMITH and WALTER (1985) and a 3-compartment model introduced by DENIS (1984). The scheme assesses the integrity of the intervertebral disc which accounts for most of the rotational and lateral bending stability (SHIRES et al., 1991; SCHULZ et al., 1996), the vertebral body, which acts as a buttress against axial loading and bending, and the articular facets, which resist all forces (SMITH and WALTER, 1985). In our cat the vertebral arch of L1 comprising the dorsal compartment was fractured, the fragments compressing the spinal cord. The articular facets of L1 and L2 were intact, thus rendering the fracture only minimally instable in the dorsal compartment. However, the vertebral body of L2 was sagittally fractured, leaving only the right lateral and part of the ventral cortex of the vertebral body intact. The resulting instability in lateral bending was still counteracted by the intact articular facets, so the decision not to surgically stabilize the vertebral column was made and proved successful. The main principle of surgical intervention in such cases must be to prevent further destabilisation. This was accomplished by a lateral approach (SEEMAN, 1968; FLO and BRINKER, 1975) which maximized surgical exposure while making it possible to remove the fracture fragments without the excision of the articular processes of L1 and L2.

Pathophysiologic changes that occur in the spinal cord

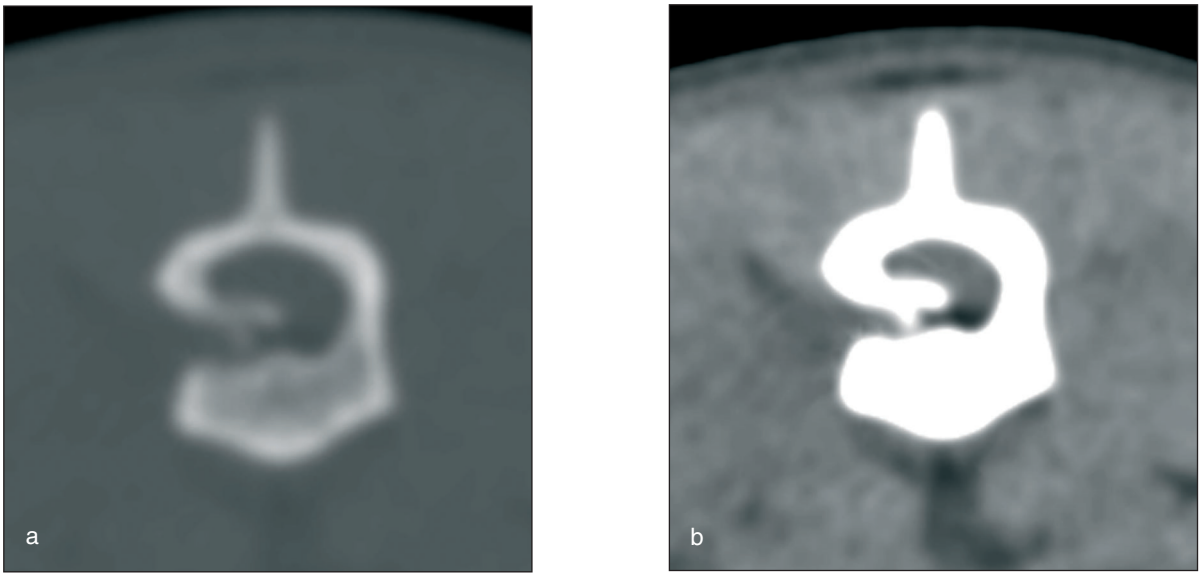

Fig. 3: Transverse single slice CT images of the first lumbar vertebra in a bony (a) and soft tissue (b) window; the left vertebral arch reveals an impression fracture with a nearly lamellar bony fragment being dislocated into the vertebral canal. The bone dislocates and compresses the spinal cord dorsally and to the right.

after trauma include ischemia, hemorrhage, alterations in spinal cord blood flow and edema in addition to the primary compressive lesion (BERG and RUCKER, 1985; JANSSENS, 1991; QUENCER and BUNGE, 1996). This effect is termed secondary injury, putative mediators of this self-perpetuating process include excitatory neurotransmitters, endorphins, catecholamines and free radicals and lead to necrosis and apoptosis of neurons and oligodendrocytes (BAGLEY, 2000). In severe cases myelomalacia can develop due to the resulting progressive vasospasm (GRIFFITHS, 1972). This condition leads to progression from upper motoneuron to lower motoneuron deficits and tetraparesis with abdominal breathing and terminates in hypoventilation to asphyxiation due to paralysis of the breathing musculature. Surgery is therefore not only indicated to inhibit further damage to the spinal cord by removal of compression and by treating instability, but also to prevent secondary injury. In our case, the accurate diagnosis of the bony lamella protruding into the vertebral canal and hence significantly compressing the spinal cord favoured surgical intervention despite of the relatively mild neurological deficits. Thus, further deterioration of the spinal cord could be prevented. This led to rapid recovery and a shortened hospitalisation time of the patient.

In cases of bite wounds, considerable tissue damage leading to decreased perfusion and subsequent muscle necrosis in the traumatized region has to be anticipated. This was treated by excision of damaged tissue and intravenous infusion of lidocaine, acting as a free radical scavenger (CASSUTTO and GFELLER, 2003). Intravenous administration of high doses of methylprednisolone sodium succinate have been recommended to be used within 8 hours of injury in human medicine (BRACKEN et al., 1990, 1992) to prevent lipid peroxidation following free radical liberation (BROWN and HALL, 1992). However, the benefits have been questioned by a number of studies (GEORGE et al., 1995; GERHART et al., 1995; LEVY et al., 1996; HEARY et al., 1997; NESATHURAI, 1998; HURLBERT, 2000; LECOUTEUR and STURGESS, 2003). Administration after the 8 hour therapeutic window worsens the outcome in humans while the length of this window in dogs and cats has not been determined (BRACKEN, 2000a, b; HURLBERT, 2000). Including these considerations and the danger of reported side effects which are gastrointestinal ulceration and bleeding (ROHRER et al., 1999a, b), we decided not to give corticosteroids.

In our case radiographs could not clearly assess the fracture fragments, especially those originating from L1 as they were only displaced minimally in a transverse plane. In contrast, CT could easily detect those fragments within the vertebral canal, and we were able to rule out articular facet fractures. In conclusion, CT imaging can substantially aid the surgeon to decide about treatment modalities, reduce surgical trauma and thus decrease hospitalisation time of the animal.

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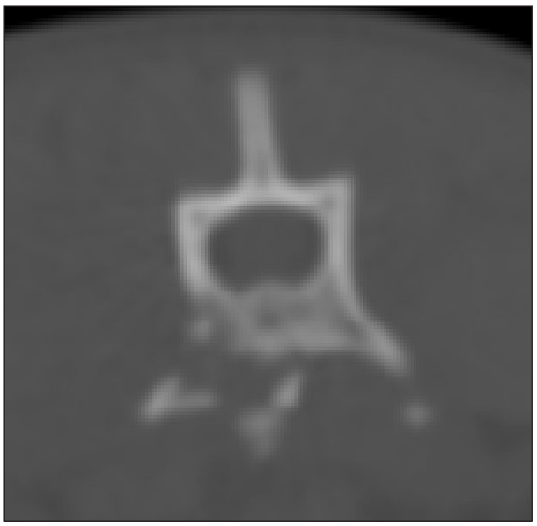

Fig 4: Transverse CT image of the second lumbar vertebra with a comminuted fracture of the ventral aspects of the vertebral body

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