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Traumatic spinal cord injury in cats: three years epidemiologic study and late characterization of lesions by computerized tomography imaging analysis

Euler Moraes Penha[1]; Gillian Macário Cardoso[2]; Rodrigo Lima Carneiro[3]; Emanoel Ferreira Martins Filho[4]; Deusdete Conceição Gomes Junior[5]; Vinicius de Jesus Moraes[6]; Wagner Ribeiro Aguiar[7]; Milena Botelho Pereira Soares[8]

1- Doutorando em Biotecnologia em Saúde e Medicina Investigativa pela Fundação Oswaldo Cruz. Funcionário do setor de diagnóstico por imagem da Universidade Federal da Bahia.
2. Médico Veterinário autônomo formado pela Universidade Federal da Bahia - UFBA.
3- Mestrando em Ciência Animal nos Trópicos - Universidade Federal da Bahia
4- Doutorando em Cirurgia Veterinária - Universidade Estadual Paulista Júlio de Mesquita Filho
5- Mestrando em Cirurgia Veterinária - Universidade Estadual Paulista Júlio de Mesquita Filho
6- Mestrando em Ciência Animal nos Trópicos – Universidade Federal da Bahia
7- Pós-Graduação em Matemática e Estatística – Universidade Federal de Lavras
8- Doutorado em Ciências Biológicas - Universidade Federal do Rio de Janeiro

Abstract

Late complications of spinal cord injury in cats are not well known. Current imaging methods allow the acquisition of more detailed information and guide

the choice of treatment. We evaluated 22 cats, and in 6, we draw an epidemiological late traumatic lesions in the spinal cord, characterizing by means of computed tomography (CT), its natural evolution. The causes of trauma in the animals evaluated were falling through the window of apartment and car accidents, firearm, and intentional human assault. The location of trauma were: T7 to T11 in three cats, T12 to L2 in 17 cats; L3 to L7 in two cats. By CT we observed the presence of hypoattenuation area surrounding the spinal cord with atrophy in six cats. Compressive lesion was absent in one animal, one was mild, and severe in four others. Fractures in the dorsal and ventral compartments were observed in 50% and 33.34% of cases, respectively. In three animals the lesion was multiple and involved the pedicles and intervertebral discs. Although it was possible to locate and describe the lesions in the bone tissue, the observation and classification of lesions in adjacent soft tissues were unsatisfactory. Few animals survived after trauma to the spinal cord over the three years of observations, thus we indicate the use of other diagnostic tools like magnetic resonance imaging and electroneuromyography to develop more effective therapeutic approaches aiming the increasing of life expectancy with quality of animals with spinal cord injury.

Keywords: spinal cord, neurorthopedics, feline, spinal trauma

Lesões raquimedulares traumáticas em gatos: Estudo epidemiológico por três anos e caracterização tardia das lesões através da tomografia computadorizada

Resumo

As complicações tardias de lesão medular em gatos não são bem conhecidas. Os atuais métodos de imagem permitem a aquisição de informações mais detalhadas e direcionam a escolha do tratamento. Avaliamos 22 gatos, e em 6, traçamos um panorama epidemiológico tardio de lesões traumáticas na medula espinhal, caracterizando sua evolução natural por meio de tomografia

computadorizada (TC). As causas de trauma nos animais avaliados foram: queda através da janela de apartamento; acidente automobilístico; arma de fogo; e agressão humana intencional. O local do trauma foi: T7 a T11 em 3 gatos; T12 a L2 em 17 gatos; L3 a L7 em 2 gatos. Através da TC observamos a presença de área hipoatenuante circundante com atrofia da medula espinhal nos 6 gatos. Lesão compressiva estava ausente em um animal, em um era discreta, e grave em outros quatro. Fraturas nos compartimentos dorsal e ventral foram observadas em 50% e em 33,34% dos casos, respectivamente. Em três animais a lesão foi múltipla e envolveu os pedículos e discos intervertebrais. Apesar de ter sido possível localizar e descrever as lesões no tecido ósseo, a observação e classificação das lesões em tecidos moles adjacentes foram insatisfatórias. Poucos animais sobreviveram após o traumatismo na medula espinhal ao longo dos três anos de observação, desta forma indicamos que outras ferramentas de diagnóstico como a ressonância magnética e a eletroneuromiografia sejam utilizadas para o desenvolvimento de abordagens terapêuticas mais eficazes objetivando aumentar a expectativa de vida com qualidade dos animais portadores de lesão medular.

Palavras-chave: medula, neurortopedia, felino, trauma raquimedular

INTRODUCTION

Trauma of the spine and spinal cord is one of the most usual neurological diseases in small animal clinics. It is usually a result of injury by gunshot, human being aggression, falls, and trampling. Traumatic rupture of spinal cord and soft structural tissue surrounding may cause fracture, vertebrae dislocation or subluxation and the traumatic extrusion of intervertebrae disk, and thus promote some spinal cord disfunction (OMOJOLA, 2011). The spinal trauma of sufficient magnitude to cause such injuries, commonly results in compression, contusion, concussion and laceration of the spinal cord (BRAUND, 1996; ; OMOJOLA, 2011), thus causing ataxia, paresis or paralysis in animals (CHRISMAN, 1985). These disorders frequently occur at the junction of

vertebral mobile segment with another segment property, or in its vicinity as a resultant of tension increasing (BRUECKER & SEIM, 1998).

The acute trauma of spinal cord usually results in neurological defects and mechanical breakdown by smashing the neural and vascular elements at the time of injury (BRAUND, 1996). The basic mechanisms in acute injury to the spinal cord are the anatomical interruption, compression, concussion and ischemia (SILVEIRA, 2005; BAHR ARIAS et al., 2007; OMOJOLA, 2011), in addition to bruising, bleeding, edema and congestion, which usually are attached to most other lesions. The interruption of the spinal cord parenchyma caused by laceration of the nerve tissue can cause changes considered incurable and irreversible. The lesions cause a slight loss of proprioception, reflexes, causing serious loss of capacity to sustain weight loss of voluntary movement and finally the sensation of deep pain (WHEELER & Sharp, 1999a). Injuries cause slight loss of proprioception reflexes, causing serious loss of capacity to weight bearing, loss of voluntary movement and, at last, loss of deep pain sensation (WHEELER & SHARP, 1999a). The result of mechanical compression neuropathies is axonal degeneration and secondary demyelination (GALIS & MEIRELES JUNIOR, 1999). Although it has been demonstrated partial recovery of spinal lesions (BRUSTEIN & ROSSINGOL et al., 2007), the prognosis is always bad when there are complete lesions (FOSSUM, 2002).

Methods of diagnostic imaging contribute important information in defining the diagnosis and surgical planning, and establish a prognosis (LAURER et al., 2007). This study aims to describe the occurrence of spinal injuries in cats and characterize late natural spinal cord injuries of six domestic cats, by the CT scan.

MATERIAL AND METHODS

During three years there were observed 22 cats with spinal cord lesion located caudally to T7 vertebrae, within 1st degree and zero point of neurologic deficit obtained by behavioral assessment using the 15-point OLBY et al.

(2001) scoring system (Table 1). The cats' gait was independently scored before the beginning of radiographic assessment for spinal trauma evaluation.

Table 1. Assessment of pelvic limb function by Olby score*

Stage	Point	Neurological status
1	0	No pelvic limb movement and no deep pain sensation.
	1	No pelvic limb movement with deep pain sensation.
	2	No pelvic limb movement but voluntary tail movement.
2	3	Minimal non-weight-bearing protraction of pelvic limb (movement of one joint).
	4	Non-weight-bearing protraction of pelvic limb with more than one joint involved less than 50% of the time.
	5	Non-weight-bearing protraction of pelvic limb with more than one joint involved more than 50% of the time.
3	6	Weight-bearing protraction of pelvic limb less than 10% of the time.
	7	Weight-bearing protraction of pelvic limb 10-50% of the time.
	8	Weight-bearing protraction of pelvic limb more than 50% of the time.
4	9	Weight-bearing protraction 100% of time with reduced strength of pelvic limb. Mistake > 90% time.
	10	Weight-bearing protraction of pelvic limb 100% of time with reduced strength. Mistake 50-90% of the time.
	11	Weight-bearing protraction of pelvic limb 100% of time with reduced strength. Mistake < 50% of the time.
5	12	Ataxic pelvic limb gait with normal strength, but mistakes made > 50% of time.
	13	Ataxic pelvic limb gait with normal strength, but mistakes made < 50% of time.
	14	Normal pelvic limb gait.

*Olby et al., 2001.

Of the twenty-two cats studied, two animals are still alive. Twelve animals died in less than five weeks in consequence of the trauma or were euthanized due to injuries associated with spinal cord involvement, four died after two years due to other causes, and the six surviving cats underwent computed tomography, and two died of natural causes six months after the examination. The causes of trauma include falling through window of apartment building (9 cats; 40.9%); automobile accident (11 cats; 50%); firearms shot (1 cat; 4.5%) and intentional hitting trauma caused by a human being (1 cat; 4.5%). The location of trauma were thoracic (from T7 to T11; 3 cats; 13.6%); thoracic-lumbar (from T12 to L2; 17 cats; 77.3%) and lumbar (from L3 to L7; 2 cats; 9.1%).

The six animals were evaluated with CT examination in a fourth generation scanner (Picker IQ / Xtra, Phillips Medical Systems, USA). Technical settings for all CT scans were: 130 kVp, mAs 440, 480 cm field size, image size 160 cm, slice thickness 5 mm and slice gap of 4 mm. Every animal was induced to anethesic plane with propofol (8 mg / kg) and submitted to tracheal intubation for inhalator anesthesia with isoflurane (0.6-2L rate: min, concentration of 0.5 to 4%). During all procedure the cats were monitored by a multiparametric equipment (SURGIVET – model V9203 – Wankesha – USA).

For classification of lesions using CT there were used six qualitative parameters, as follows: (a) attenuation of the subarachnoid space – defined by loss of ventral epidural fat, decreased subarachnoid space, deformed spinal cord, and small spinal, (b) fracture in the dorsal compartment, (c) fracture within the ventral compartment, (d) spinal stenosis - defined as narrowing of the vertebral canal/foramina due to thickened lamina, thickened pedicles and/or bulbous articular processes (JACOBSON at al., 1975; BARNETT et al., 1987), (e) Multiple lesions occurrence – defined as fractures located within dorsal and ventral compartments and (f) Spinal cord deformity - defined as ventral concavity in cord margin, unilateral flattening of cord margin, lateral deformity on both sides of cord, and/or triangle-shaped cord (spinal cord atrophy) (YU et al., 1986). The classification of compression by hypodense

area and by direct measurement of the area of the spinal canal from measurements in axial are described in table 2 (A and B). The parameters of fracture in the dorsal or ventral compartment, and multiple compartments were classified as positive (1) or negative (0). The results are shown in table 3.

Table 2 – Compressive parameters evaluated by CT in cats

A - Compression estimative by hypodense area surrounding the spinal cord

Degree	Compression	Findings description
1	Absent	Presence of hypoatenuating area surrounding all the spinal cord.
2	Discrete	Absence of hypoatenuating area surrounding less than 20% of the spinal cord
3	Moderate	Absence of hypoatenuating area surrounding from 20% to 45% of the spinal cord
4	Severe	Absence of hypoatenuating area surrounding more than 45% of the spinal cord

B - Evaluation of spinal cord diameter

Degree	Classification	Findings
1	Absent	Lumen of spinal canal preserved *
2	Low compression	Lumen of spinal canal reduced until 15%*
3	Medium compression	Lumen of spinal canal reduced from 16% to 35%*
4	Severe compression	Lumen of spinal canal reduced more than 36%*

* when compared to a nearby vertebrae on the same animal.

Table 3 – Sumary of late CT findings in natural spinal lesions in cats

Animal / Parameter	1	2	3	4	5	6
Hypodense area surrounding the spinal cord	4	4	4	4	4	4
Dorsal compartment fracture	1	1	0	0	1	0
Ventral compartment fracture	1	0	0	0	1	0
Spinal compressions areas by axial CT slices by canal surface mensurations.	4	4	4	2	4	1
Multiple lesions localizations	1	1	0	0	1	0

RESULTS AND DISCUSSION

The causes of trauma observed with this research were the same as previously reported, but the occurrence of a larger number of lesions caused by falls (40.1%) was not expected. There are no data available on epidemiological survey of spinal injuries in cats linking the most frequent causes of their occurrence, as previously reported in the human beings (UMPHERED & SCHINEIDER, 1994) and canine (SMITH & WALTER, 1985). Despite the small number of animals evaluated, the principal cause of spinal trauma observed in domestic cats was far different from those observed in the others species: The first most prevalent cause was fall while in those species trampling is the most frequent cause (OMOJOLA, 2011). Cat's way of life has been changing interestingly in last decade, with the advent of even more owner's preference in apartment buildings. Surprisingly, almost all the buildings that have fallen cats were fitted with gauze of security, except in two (9.1%). Some of these were very old and others were not suitable for cats. In

one case (4.5%) the accident occurred at a residence equipped with safety equipment certificate for cats.

Lesions were more frequent from T12 to L2 vertebrae (77.3%) - the four live animals are included in this group - and two (9.1%) were located in lumbar spine. Those occurrences are corroborated by researchers (BRAUND, 1996; BRUECKER & SEIM, 1998). At least, in part, the absence of incoming patients presenting lesions from C1 to T7 vertebrae are supposed to occur due to cats lifestyle that doesn't allow the owners to indulge, then their pet gets sick, pondering they are not able to move back home. This data probably is misunderstood.

The injury further observed by CT was the severe compression of the spinal canal by absence of hypo signal surrounding cord area in 100% of cases with spinal cord atrophy (triangle shaped), what is corroborated by another researchers in other species (YU et al., 1986). When judged only by the compression caused by bone deformity, one animal (16.7%) had preserved area and one animal showed slight compression. Fracture in the dorsal compartment was observed in 50% of cases and within the ventral fracture in 33.34% of cases. In three animals (50%) injuries occurred in multiple locations. The summary of findings is shown in table 3 and figure 1.

It is believed that the occurrence of multiple lesions in 50% of the cases, justify the previously and widely reported difficulty in clinical classification of the lesions by other radiographic methods (BRAUND, 1996; WHEELER & SHARP, 1999b; SILVEIRA, 2005; BAHR ARIAS et al., 2007).

A very little number of cats had survived after spinal cord lesions within this research after a three years observation period. Efficient therapeutical approaches are required to increase life length with quality in cats.

With the CT it was possible to locate and describe the injuries, especially those that occurred in bone tissue. However, the observation and classification of lesions in adjacent soft tissues were not satisfactory. It is suggested the use of nuclear magnetic resonance and assessment by motor/sensitive evoked potentials for a more complete evaluation.

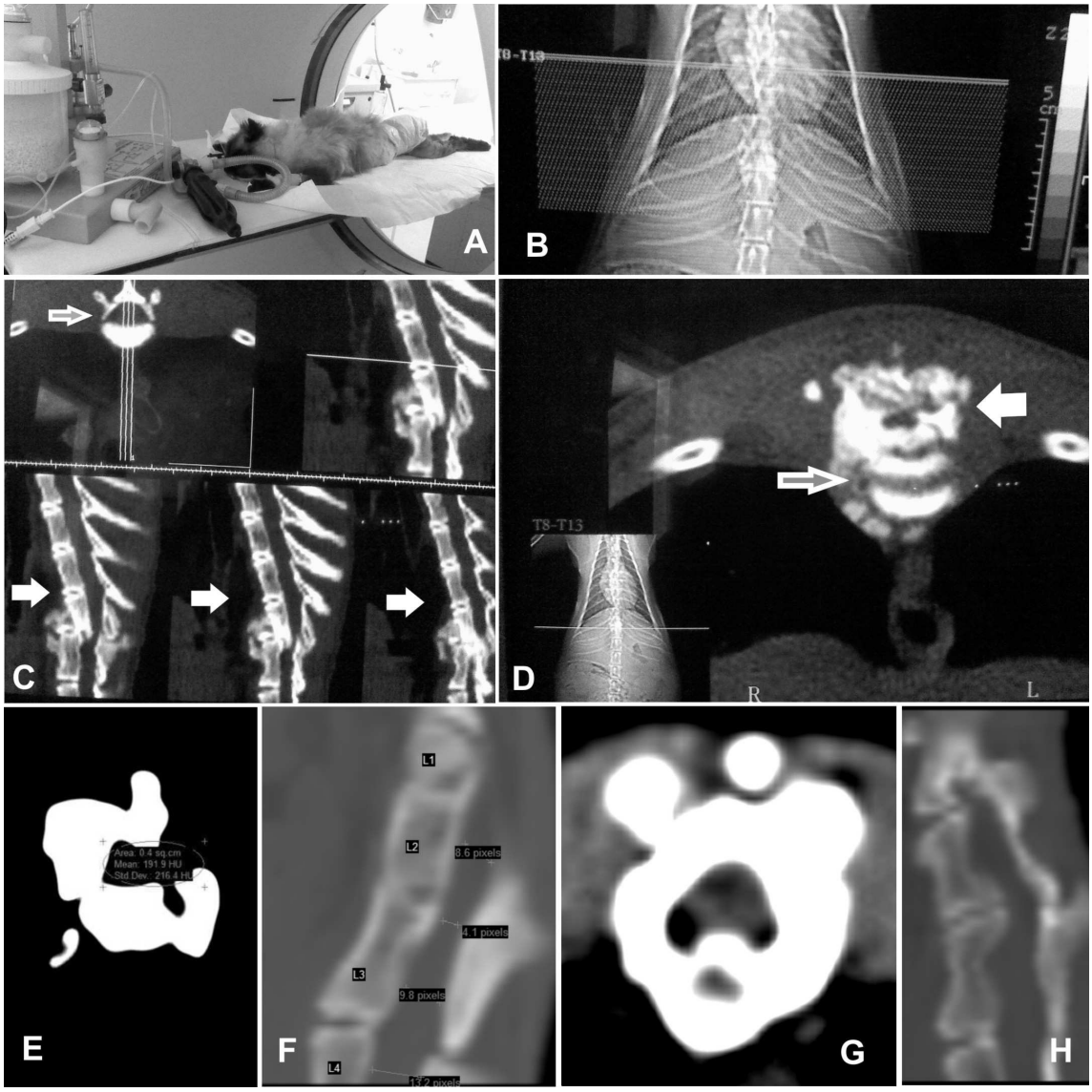

FIGURE 01: Technical implementation of the CT scan. (a) First the animal is under general anesthesia for (b) completion of scout, delimiting area to be assessed from Cross-Sectional sections. With the method it is possible to (c) take pictures of saggital (white arrows) or axial (open arrow), making a relationship of the lesions localization in both (white line). (d) From axial sections the location of the lesion can still be determined, if the injury is within the ventral (open arrow) and the dorsal (large white arrow). When changing the degree of contrast given the structures, for example, then the equipment in the window to skeleton (e) all the images corresponding to soft tissues

(including spinal cord) are disregarded from view. From this window the area of cross section can be calculated (area surrounding by yellow dotted line) and the signal strength in the area so far (Figures in HU within the channel) (f) if it is of interest to assess the dimensions of channel and the degree of signal strength in a wide variety of items, it can be achieved with the use of two-dimensional reconstructions. (g) From axial sections can be observed around the hypodense area cord, thus suggesting the degree of spinal compression. (h) With the use of two-dimensional reconstruction is possible to have idea of the magnitude of compression. It is also to assess the degree of a new born bone by narrowing of spinal space.

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