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Retrospective study on the incidence of cats and dogs' spinal injuries by computed tomographic scan. Part II: Thoracolumbar and lumbosacral*

Estudo retrospectivo sobre incidência de injúrias em coluna vertebral de cães e gatos por meio de exame tomográfico. Parte II: Toracolombar e Lombossacral

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Abstract

For vertebromedullary injuries, epidemiological knowledge is essential to guide the choice of the most effective diagnostic method. The objective of this retrospective study was to describe the epidemiological profile of animals and thoracolumbar and lumbosacral spine lesions diagnosed by computed tomography scan. A compilation of CT scan reports for the aforementioned regions performed in a comercial diagnostic center from 04/01/2017 to 04/30/2020, contrasted and non-contrasted, from routine, was performed in order to list the most common lesions and their locations, as well as the species, breeds and ages most affected. There were 1164 CT scans performed in the period evaluated, all of them in dogs, 57,56% (n=670) for the spine, with 89,7% reports accessed (n=601), where the regions mentioned here added up to 73,05% studies (n=439). In both regions, male French Bulldog dogs had the most injuries. For the thoracolumbar region, disk mineralization, followed by extrusion, were the most frequent injuries, while the site was T12-13 and the mean age 6,5±3,63 years old. In the lumbosacral, disk protrusion was most frequent, the most affected site was L7-S1 and age 6,65±3,79 years. It was concluded that the spine is the main target of CT scans, and that lesions related to the intervertebral disk were the main ones identified, with chondrodystrophic animals being more predisposed to injury.

Keywords: computed tomography, dogs, epidemiology, spinal cord, neurology.

Resumo

Para lesões vertebromedulares é indispensável o conhecimento epidemiológico para direcionar a escolha do método diagnóstico mais eficaz. O objetivo desse estudo retrospectivo foi descrever o perfil epidemiológico dos animais e das lesões em coluna vertebral toracolombar e lombossacral diagnosticadas através de exame tomográfico. Realizou-se a compilação de laudos de tomografias computadorizadas para as referidas regiões realizadas em centro diagnóstico comercial, entre 01/04/2017 a 30/04/2020, contrastadas e não-contrastadas, provenientes da rotina, a fim de relacionar as lesões e seus locais de ocorrência, bem como a espécie, raças e idades mais comuns. Foram realizados 1164 exames tomográficos no período avaliado, sendo 57,56% (n=670) para a coluna, com 89,7% laudos acessados (n=601), nos quais as regiões toracolombar e lombossacral somaram 73,05% dos estudos (n=439). Em ambas as regiões, os cães Bulldog Francês machos foram os que mais apresentaram lesões. Para a região toracolombar, a mineralização de disco, seguida pela extrusão, foram as lesões mais frequentes, enquanto o local foi T12-13 e a média de idade 6,5±3,63 anos. Na lombossacral, a protusão de disco foi mais frequente, o local mais afetado foi L7-S1 e idade de 6,65±3,79 anos. Concluiu-se que a coluna vertebral é o principal alvo de tomografias, e que as lesões relacionadas ao disco intervertebral foram as principais identificadas, sendo os animais condrodistróficos mais predispostos a lesões.

Palavras-chave: cães, epidemiologia, medula espinhal, neurologia, tomografia computadorizada.

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Introduction

The canine and feline spines are anatomically divided into segments, the thoracic portion being composed by 13 vertebrae (T1-13), lumbar with seven (L1-7) and sacrum containing three fused vertebrae (Singh, 2017). It is composed of bony, ligamentous, muscular and nerve segments, mainly, and is responsible for supporting the body axis and protecting noble structures, such as the spinal cord, which is also protected by meninges. Its joints are given, in most of its junctions, by the presence of the intervertebral disk, except in the sacral vertebrae, which undergo a fusion process through the body anatomical development (Singh, 2017).

The intervertebral disk (IVD) represents great importance from a clinical and anatomical standpoint. Anatomically, it is responsible in part for the mobility of the spine (Singh, 2017). Clinically, it may cause manifestations of varying severity. The clinical signs of patients with spondylomyelopathies, be it of any origin, mainly include neurological deficits (Jeffery et al., 2013), and are related to the location of the lesion, where the signs may vary, in general, as to the functional region of the spinal cord in a particular portion of the spine, causing the aforementioned thoracolumbar (T3-L3) and lumbosacral (L4-S3) syndromes (Costa and Moore, 2010). The clinical evaluation will determine the probable affected region, directing the complementary exams.

Imaging tests are widely used for diagnosis or screening of affected animals, and can be conclusive in most cases (Costa et al., 2020). Plain radiography, myelography computed tomography (CT), myelotomography and magnetic resonance imaging (MRI) are the most commonly used imaging methods (Mendes and Bahr Arias, 2012; Costa et al., 2020).

CT represents the most advanced imaging diagnosis modality available in Maringa-PR region. Therefore, this study aimed to perform a retrospective study of pathological processes of the thoracolumbar and lumbosacral spine diagnosed by CT scan in order to draw an epidemiological profile of the injuries and of the affected animals.

Material and methods

This retrospective study was conducted in the city of Maringa, Parana, Brazil, in partnership with the imaging diagnosis stablishment NAV – *Núcleo de Apoio Veterinário*®, where the tomographic reports of exams performed between 04/01/2017 to 04/30/2020 were accessed, without predilection for species, breed, sex, age and other assignments, in possession of the company's digital archive. These CT scans result from the clinical and elective routine of the establishment, being performed using a General Electric Hispeed® scanner, with single-slice technology, in sequential cuts with an average thickness of two millimeters.

The animals were submitted to general anesthesia and inhalation anesthetic maintenance for the procedure. The reports were prepared by professionals in the area of diagnostic imaging. The target regions were standardized as: cervical, cervicothoracic, thoracolumbar and lumbossacral spine. The injection of iodine-based contrast (Iopamiron® 300, Iopamidol, Bracco, Brazil) was done through the cisterna magna in the atlanto-occipital joint after trichotomy and surgical antisepsis of the area, at a dose of 0,1ml/kg, associated with 0,2ml/kg of NaCl 0,9%, in order to allow visualization of spinal compressions when necessary.

After the verification and quantification of the reports in general in the period described above, only the exams directed to the thoracolumbar (T3-L3) and lumbosacral (L4-S3) (Costa and Moore, 2010) spine were selected and accessed, although they could show vertebrae and intervertebral spaces near the margin of the regions supported by the exam, which ones were included in the statistical analysis too. Through this access and data compilation, epidemiological analyses were established about the thoraculumbar and lumbosacral segments and the vertebrae and intervertebral spaces near this regions showed by the CT to relate the main regions of exams, as well as the occurrence of injuries and their locations, and also to identify the main affected animals and their age, sex and race predispositions. Finally, logistic regression models were considered to identify the effects of sex and age on the occurrence or not of injuries. A binary logistic regression model using the R - GNU software (version 4.0.3) was considered to determine the relationship between the occurrence of lesions in the evaluated segments and the age or sex of the affected animals. The estimates of the Odds Ratio (OR) and the 95% confidence interval were obtained from the intercept of each factor considered, based on the Wald process, in order to establish the relationship between the variables. In addition, it was performed four groups of animals according to the age, being from zero to four years, five to eight years, nine to twelve years, and thirteen to sixteen years old, in order to stablish a descritive analisis of the most commom injuries, locations and breeds.

Results

A total of 1164 tomographic exams were performed in the evaluated period, 670 (57,56%) focusing on the spine and performed only in canine animals. Of the total, 601 reports were located and accessed (601/670 – 89,7%), which were computed for the analyses described. Of these 601 reports, the thoracolumbar region was identified as the main object of study, with 312 (51,91%) reports, followed by 131 (21,8%) for the cervical spine, 127 (21,13%) for the lumbosacral region, and 31 (5,16%) for the cervicothoracic region.

For the thoracolumbar region, a total of 312 reports were accessed, where 268 (268/312 – 85,9%) presented pathological alterations and 44 were unaltered (44/312 – 14,1%), besides being identified lesions outside the spine in 43 animals (43/312 – 13,78%). Regarding the total, 160 dogs were male (160/312 – 51,28%) and 152 were female (152/31 – 48,72%). For 144 dogs, joint exams of other regions were performed (144/312 – 46,15%), adding 179 regions to the total, being lumbosacral (102/179 – 56,98%), cervical (33/179 – 18,44%) and cervicothoracic (12/179 – 6,7%) the main ones evaluated.

The figure 1 shows the occurrence of lesions according to sex. The sum of lesions in all reports accessed for both regions was 1110, with na average of 3,56 lesions per exam. The lesions, together with their places of occurrence were listed in tables 1, 2, 3 and 4. The main changes were: mineralization (297/1110 – 26,76%), extrusion (219/1110 – 19,73%), ventrolateral spondylosis (170/1110 – 15,31%), protrusion (166/1110 – 14,95%) and hemivertebrae (98/1110 – 8,83%). The most frequent locations were T12-13 (129/1110 – 11,62%), T13-L1 (106/1110 – 9,55%), L1-2 (106/1110 – 9,55) and L2-3 (102/1110 – 9,19%). The mean age for examination was 6,41±3,7 years, while for lesion occurrence was 6,5±3,63 years.

Figure 1: Frequency of occurrence of thoraculumbar spine injuries distributed according to the sex of dogs submitted to computed tomography in the city of Maringá-PR, between 01/04/2017 to 04/30/2020

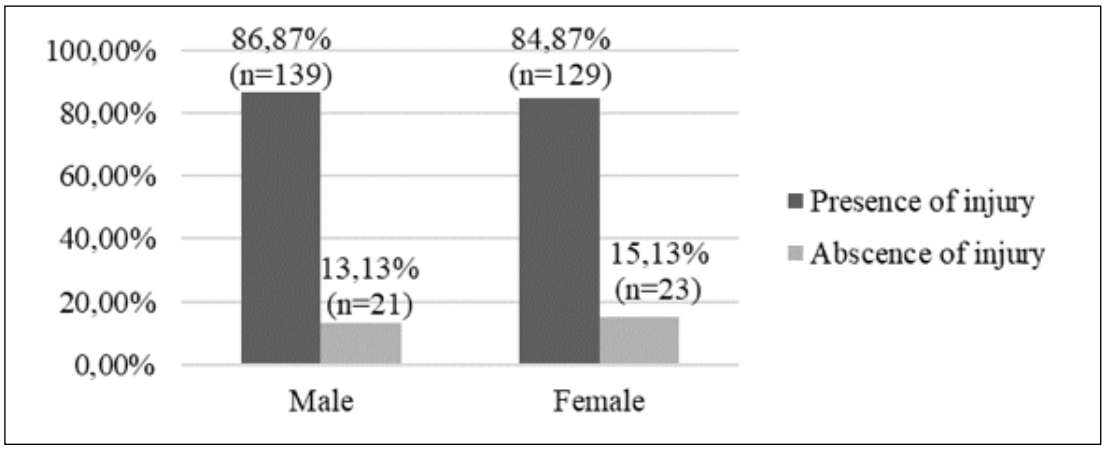

Table 1: Lesions (n) occurring in the thoracolumbar spine, segment T1-2 to T6-7, identified through compiled reports of CT sacns performed in dogs

	T1-2	T2-3	T3	T3-4	T4	T4-5	T5	T5-6	T6	T6-7
Bone cyst	0	0	0	0	0	0	0	0	0	1
Idiopathic compression	0	0	0	1	0	0	0	0	0	0
Scoliosis	0	0	0	0	0	0	0	0	1	0
Ventrolateral spondylosis	0	0	0	1	0	4	0	8	0	8
Extrusion	0	0	0	0	0	1	0	0	0	1
Vertebral fracture	0	0	0	0	0	0	0	0	1	0
Spiny process fusion	0	0	0	0	0	1	0	1	0	1
Hemivertebrae	0	0	1	0	2	0	5	0	16	0
Spinal cord inflammation	0	1	0	0	0	0	0	0	0	0
Dislocation	0	0	0	0	0	0	0	1	0	0
Mineralization	4	2	0	2	0	3	0	3	0	12
Metastasis	0	1	0	0	0	0	1	0	1	0
Vertebral neoplasia	0	0	1	0	1	0	1	0	0	0

Table 2: Lesions (n) occurring in the thoracolumbar spine, segment T7 to T11-12, identified through reports compiled from CT scans performed in dogs

	T7	T7-8	T8	T8-9	T9	T9-10	T10	T10-11	T11	T11-12
Kyphoscoliosis	0	0	0	0	0	0	0	0	2	0
Kyphosis	1	0	2	0	1	0	1	0	0	0
Bone cyst	0	0	0	0	0	0	0	0	1	0
Discospondylitis	0	0	0	2	0	0	0	0	0	1
Dysp. caudal j. proc.	0	0	0	0	0	0	0	0	1	0
Enostosis	1	0	1	0	0	0	0	0	0	0
Enthesophytosis	0	0	0	0	0	1	0	1	0	0
Spondylitis	0	0	0	0	0	0	0	0	1	0
Spondylosis	0	6	0	5	0	16	0	9	0	15
Extrusion	0	0	0	0	0	3	0	3	0	24
Vertebral fracture	0	0	1	0	0	0	0	0	3	0
Joint process fusion	0	0	0	0	0	0	0	1	0	0
Spiny process fusion	0	0	0	1	0	0	0	0	0	0
Hemivertebrae	11	0	12	0	13	0	15	0	10	0
Spinal cord inflammation	1	0	0	1	0	1	0	1	0	1
Dislocation	0	1	0	0	0	1	0	1	0	1
Multiple myeloma	0	0	0	0	0	0	1	0	1	0
Mineralization	0	18	0	16	0	18	0	42	0	35

	T7	T7-8	T8	T8-9	T9	T9-10	T10	T10-11	T11	T11-12
Metastasis	1	0	2	0	1	0	1	0	2	0
Vertebral neoplasia	1	0	1	0	2	0	3	0	1	1
Protrusion	0	0	0	1	0	6	0	3	0	13
Radiculopathy	0	0	0	0	0	0	0	2	0	1
Fibroc. thrombus	0	0	0	0	0	0	1	0	0	0

Dysp. = Dysplasia; j. = joint; proc. = process; fibroc. = fibrocartilaginous.

Table 3: Lesions (n) occurring in the thoracolumbar spine, from T12 to L3, identified through reports compiled from CT scans performed in dogs

	T12	T12-13	T13	T13-L1	L1	L1-2	L2	L2-3	L3
Kyphoscoliosis	0	1	0	0	0	0	0	0	0
Arachnoid cyst	1	0	0	0	0	0	0	0	0
Bone cyst	0	0	0	0	1	0	0	0	0
Discospondylitis	0	3	0	0	0	2	0	0	0
Interapophyseal joint dysplasia	0	1	0	0	0	0	0	0	0
Enostosis	0	0	0	0	0	0	1	0	0
Enthesophytosis	0	1	0	0	0	1	0	0	0
Ventrolateral spondylosis	0	17	0	13	0	29	0	18	0
Extrusion	0	47	0	41	0	32	0	30	0
Vertebral fracture	2	0	2	0	2	0	0	0	0
Hansen III	0	1	0	1	0	0	0	0	0
Hemivertebrae	6	0	5	0	1	0	1	0	0
Spinal cord inflammation	0	1	1	0	0	0	1	0	1
Dislocation	0	0	0	0	0	0	0	1	0
Multiple myeloma	1	0	1	0	1	0	1	0	1
Mineralization	0	34	0	26	1	23	0	25	0
Metastasis	3	0	2	0	5	0	3	0	3
Vertebral neoplasia	1	0	2	0	1	0	2	0	2
Osteophytosis	0	0	0	0	0	0	1	0	0
Epiphyseal osteophytosis	0	0	0	0	1	0	0	0	0
Osteopenia	0	0	0	1	0	0	0	0	0
Protrusion	0	22	0	24	1	16	0	27	0
Radiculopathy	0	1	0	0	0	3	0	1	0
Transitional vertebrae	0	0	5	0	7	0	0	0	0

Table 4: Lesions (n) occurring in the thoracolumbar spine, segment L3-4 to L6-7 and meninges, identified through compiled reports of CT scans performed in dogs

	L3-4	L4	L4-5	L5	L5-6	L6-7	Meninge
Ankylosis	0	0	1	0	0	0	0
Bone cyst	0	0	0	1	0	0	0
Discospondylitis	1	0	0	0	1	0	0
Enthesophytosis	0	0	0	0	0	0	0
Spondylosis	14	0	7	0	0	0	0
Extrusion	22	0	13	0	2	0	0
Hansen III	1	0	0	0	0	0	0
Spinal cord inflammation	0	1	0	0	0	0	0
Meningeal inflammation	0	0	0	0	0	0	1
Multiple myeloma	0	1	0	0	0	0	0
Mineralization	20	0	10	0	1	1	1
Meningeal neoplasia	0	0	0	0	0	0	2
Metastasis	0	1	0	0	0	0	0
Vertebral neoplasia	0	3	0	1	0	0	0
Protrusion	33	0	20	0	0	0	0
Radiculopathy	1	0	0	0	0	1	0

The most affected breeds were French Bulldogs (204/1110 – 18,38%), Dachshund (153/1110 – 13,78%), Lhasa Apso (149/1110 – 13,42%), MBD (107/1110 – 9,64%) and Shih Tzu (98/1110 – 8,83%).

Mineralization occurred 58% in male and 42% in female, mainly in Dachshund (68/297 – 22,9%), followed by Lhasa Apso (59/297 – 19,86%) and Shih Tzu (39/297 – 13,13%), where the locations T10-11 (42/297 – 14,14%), T11-12 (35/297 – 11,78%) and T12-13 (34/297 – 11,45%) were most frequent for such lesion. Extrusion occurred 55% in male and 45% in female, Dachshund (37/219 – 16,89%), Lhasa Apso (35/219 – 15,98%) and Shih Tzu (29/219 – 13,24%) were the most affected breeds, and the locations T12-13 (47/219 – 21,46%), T13-L1 (41/219 – 18,72%) and L1-2 (32/219 – 14,61%) were the most common. As for ventrolateral spondylosis, it was 51% male and 49% female, where French Bulldog (23/170 – 13,53%), Dachshund (18/170 – 10,59%) and MBD (mixed-breed dog) (17/170 – 10%) were most commonly affected, while L1-2 (29/170 – 17,05%), L2-3 (18/170 – 10,59%) and T12-13 (17/170 – 10%) were the most common intervertebral spaces for diseases. Protrusion, like extrusion, occurred 55% in male and 45% in female, with Lhasa Apso (29/166 – 17,47%), Dachshund (27/166 – 16,26%) and Shih Tzu (20/166 – 12,05%) the most common breeds, while L3-4 (33/166 – 19,88%), L2-3 (27/166 – 16,26%) and T13-L1 (24/166 – 14,46%) were the most affected sites. The hemivertebrae, similarly to spondylosis, occurred 51% in males while 49% in females; the French Bulldog (82/98 – 83,67%) and English Bulldog (16/98 – 16,33%) were the breeds affected by the pathological process, and the vertebrae T6 (16/98 – 16,33%), T10 (15/98 – 15,31%) and T9 (13/98 – 13,26%) most commonly showed the alteration.

The odds ratio for thoracolumbar lesion did not identify any statistical relatioinship (p>0,05) between the sex or age of the animals, using a 95% confidence interval. For the age group zero to four years old, 462 alterations were added (462/1110 – 41,62%). The main sites of occurrence were T12-13 (47/462 – 10,17%), T11-12 (40/462 – 8,66%), T13-L1 (37/462 – 8%) and L3-4 (37/462 – 8%), being mineralization (142/462 – 30,73%), disk extrusion (89/462 – 19,26%) and hemivertebrae (87/462 – 18,83%) the most diagnosed alterations. The most affected breeds were French Bulldog (187/462 – 40,47%), Perkingese (57/462 – 12,34%) and Lhasa Apso (54/462 – 11,69%).

The five-to-eight year old group showed 356 lesions (356/1110 – 32,07%), mainly located in T12-13 (49/356 – 13,76%), L1-2 (41/356 – 11,52%) and T13-L1 (37/356 – 10,39%). The most commonly diagnosed pathological processes were disk mineralization (117/356 – 32,86%), extrusion (84/356 – 23,59%) and disk protrusion (56/356 – 15,73%), with the Dachshund (72/356 – 20,22%), Lhasa Apso (69/356 – 19,38%) and MBD (54/356 – 15,17%) breeds being the most affected. In animals aged nine to 12 years, 203 pathological processes (203/1110 – 18,29%) were summed, with ventral spondylosis (58/203 – 28,57%), disk protrusion (43/203 – 21,18%) and extrusion (36/203 – 17,73%) being the main ones. The sites L2-3 (29/203 – 14,28%), T12-13 (25/203 – 12,31%) and T13-L1 (23/203 – 11,33%) were the most commonly affected, while Dachshund (37/203 – 18,22%), Basset Hound (23/203 – 11,33%), Labrador and German Shepherd (18/203 – 8,86% each) were the most frequent breeds. For patients aged 13 to 16 years old, there were 89 diseases (89/1110 – 8,02%). The locations L1-2 (11/89 – 12,36%), L2-3 (11/89 – 12,36%) and T13-L1 (9/89 – 10,11%) had the largest number of cases, with ventral spondylosis (27/89 – 30,34%), disk protrusion (21/89 – 23,59%) and vertebral neoplasia (13/89 – 14,6%) being the most commonly identified diseases. Dachshund (18/89 – 20,22%), MBD (15/89 – 16,85%) and Lhasa Apso (12/89 – 13,48%) were the most affected breeds.

The values from now refer to the exams focused on the lumbosacral region. From the sum of 127 reports, 89 showed spinal lesions (89/127 – 70,08%), while 38 had no alteration (38/127 – 29,92%). There were also 24 animals (24/127 – 18,9%) with lesion ouotside the spine. Regarding the patients, 56 were females (56/127 – 44,1%) and 71 were males (71/127 – 55,9%). 118 animals were concomitantly submitted to tomography of other regions (118/127 – 92,91%), generating the sun of 156 target regions for new examinations, being thoracolumbar (115/156 – 73,72%), cervical (16/156 – 10,26%) and cervicothoracic (13/156 – 8,33%) the most frequent ones.

The occurrence of lesions according to the sex is shown in figure 2. The sum of alterations in the spine of all the reports was 216 (tables 5 and 6), with an average of 1,7 alterations per test performed. Protrusion (49/216 – 22,68%), mineralization (47/216 – 21,76%), ventrolateral spondylosis (37/216 – 17,13%) and extrusion (30/216 – 13,89%) were the most frequent alterations, with occurrence directed to the intervertebral spaces L7-S1 (83/216 – 38,43%), L6-7 (36/216 – 16,66%), L5-6 (31/216 – 14,35%) and L4-5 (25/216 – 11,57%) mainly. The mean age at examination, in years, was 6,64±3,95, while for lesions occurrence, it was 6,65±3,79.

Figure 2: Frequency of occurrence of lumbosacral spine injuries distributed according to the sex of dogs submitted to computed tomography in the city of Maringá-PR, between 01/04/2017 to 04/30/2020

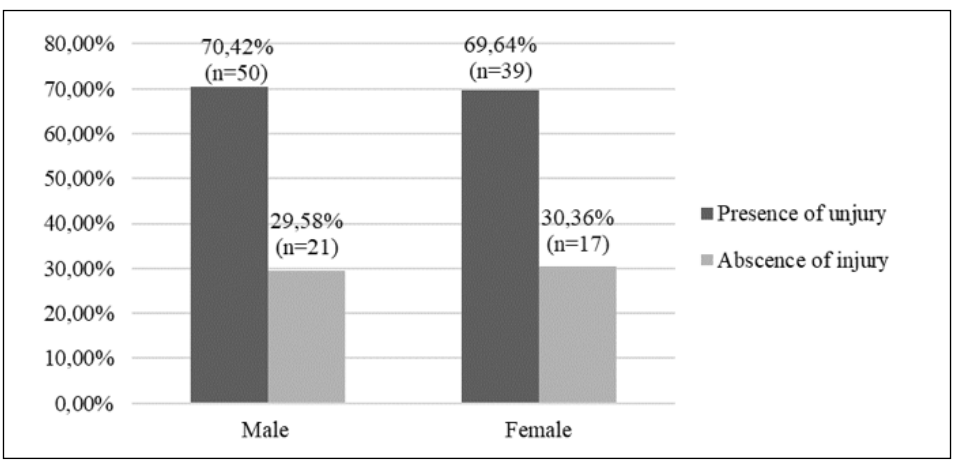

Table 5: Lesions (n) occurring in the lumbosacral spine, segment L3-4 to L6-7, identified through compiled reports of CT scans performed in dogs

	L3-4	L4	L4-5	L5	L5-6	L6	L6-7
Bone cyst	0	0	0	0	0	0	0
Discospondylitis	0	0	1	0	0	0	0
Enostosis	0	0	0	1	0	0	0
Spina bífida	0	0	0	0	0	0	0
Spondylosis	0	0	3	0	4	0	4
Extrusion	0	0	7	0	8	0	5
Vertebral fracture	0	0	0	0	0	0	0
Hemivertebrae	0	0	0	1	0	0	0
Mineralization	0	0	6	0	12	0	17
Meningeal neoplasia	0	0	0	0	0	0	0
Metastasis	0	0	0	2	0	1	0
Vertebral neoplasia	0	1	0	4	0	4	0
Protrusion	1	0	8	0	7	0	9
Radiculopathy	0	0	0	0	0	0	1
Subluxation	0	0	0	0	0	0	0
Transitional vertebrae	0	0	0	0	0	0	0

Table 6: Lesions (n) occurring in the lumbosacral spine, from segment L7 to S3 and meninges, identified through compiled reports of CT scans performed in dogs

	L7	L7-S1	S1	S1-2	S2	S3	Meninge
Bone cyst	1	0	0	0	0	0	0
Discospondylitis	0	3	0	0	0	0	0
Enostosis	0	0	0	0	0	0	0
Spina bífida	1	0	0	0	0	0	0
Spondylosis	0	25	0	1	0	0	0
Extrusion	0	10	0	0	0	0	0
Vertebral fracture	2	0	1	0	0	0	0
Hemivertebrae	1	0	1	0	0	0	0
Mineralization	0	12	0	0	0	0	0
Meningeal neoplasia	0	0	0	0	0	0	1
Metastasis	4	0	1	0	1	0	0
Vertebral neoplasia	3	0	2	0	0	1	0
Protrusion	0	24	0	0	0	0	0
Radiculopathy	0	8	0	0	0	0	0
Subluxation	0	1	0	0	0	0	0
Transicional vertebrae	5	0	0	0	0	0	0

The most affected breeds were French Bulldogs (44/216 – 20,37%), MBD (31/216 – 14,35%), Dachshund (23/216 – 10,65%) and Lhasa Apso (15/216 – 6,944%).

Protrusion occurred more commonly in males (57%) than in females (43%), and also in the intervertebral spaces L7-S1 (24/49 – 48,98%), L6-7 (9/49 – 18,37%) and L4-5 (8/49 – 16,33%), where Lhasa Apso (7/49 – 14,28%), French Bulldogs (6/49 – 12,24%) and English Bulldog (4/49 – 8,16%) were more predisposed. Disk mineralization occurred 63% in males and 39% in females, mainly affecting the L6-7 (17/47 – 36,17%), L5-6 (12/47 – 25,53%) and L7-S1 (12/47 – 25,53%) spaces, as well as the French Bulldogs (15/47 – 31,91%), Dachshund (12/47 – 25,53%) and Pekingese (5/47 – 10,64%) breeds. Spondylosis was 59% in females and 41% in males, where L7-S1 (25/37 – 67,57%), L5-6 (4/37 – 10,81%) and L6-7 (4/37 – 10,81%) were most affected, as well as the French Bulldog (7/37 – 18,92%), Germand Shepherd (6/37 – 16,22%) and Boxer (4/37 – 10,81%) animals. Extrusion was present in 53% of females and 47% of males, with a predisposition of occurrence in the intervertebral spaces L7-S1 (10/30 – 33,33%), L5-6 (8/30 – 26,66%) and L4-5 (7/30 – 23,33%), as well as in the breeds French Bulldog (7/30 – 23,33%), Dachshund (6/30 – 20%) and Rottweiller (3/30 – 10%).

The odds ratio for lumbosacral lesion did not identify any statistical relationship ($p>0,05$) between the sex and age of the animals for the occurrence of diseases, using a 95% confidence interval. Regarding the age range zero to four years, 69 pathological processes were identified (69/216 – 31,94%). The sites L7-S1 (28/69 – 40,58%), L5-6 (11/69 – 15,94%) and L4-5 (10/69 – 14,49%) were the most described, while Bichon Frise (41/69 – 59,42%) and English Bulldog (8/69 – 11,59%) the breeds. Disk mineralization (18/69 – 26,08%), protrusion (15/69 – 21,74%) and ventrolateral spondylosis (11/69 – 15,94%) were the most frequent diseases.

The five-to-eight-year age group presented the highest number of lesions (73/216 – 33,8%), which were mainly disk mineralization (24/73 – 32,87%), protrusion (16/73 – 21,92%) and extrusion (11/73 – 15,07%). The most common sites of lesions were L7-S1 (25/73 – 34,25%), L6-7 (13/73 – 17,8%) and L4-5 (11/73 – 15,06%), while the breeds, MBD (14/73 – 19,18%), Dachshund (11/73 – 15,07%) and Lhasa Apso (10/73 – 13,7%). In patients aged nine to 12 years old, 56 (56/216 – 25,93%) pathological processes were described, mainly ventral spindylosis (17/59 – 30,36%), disk protrusion (12/56 – 21,43%) and vertebral metastasis (9/56 – 16,07%). Also, the most common sites of occurrence were, respectively: L7-S1 (22/56 – 39,29%), L6-7 (11/56 – 19,64%) and L5-6 (8/56 – 14,29%), while the breeds were Labrador (9/56 – 16,07%) and German Shepherd (8/56 – 14,28%). For animals aged 13 to 16 years, there were 18 diseases (18/216 – 8,33%). The sites of occurrence were L7-S1 (8/18 – 44,44%), L5-6 (2/18 – 11,11%) and L6-7 (2/18 – 11,11%), while animals MBD (8/18 – 44,44%) and Dachshund (4/18 – 22,22%) breeds were more affected, mainly by the alterations of disk protrusion (6/18 – 33,33%) and vertebral neoplasia (5/18 – 27,77%).

Discussion

Through the elucidated results, the canine species was the only target of CT scans. Among the hypotheses for such occurrence, it is believed that because feline species are affected by discopathies in smaller proportion compared to te canine species (Decker et al., 2016), CT is not the main imaging method used for the diagnosis of vertebromedullary diseases in this species. The feline species presents a larger casuistry of vertebral fractures, thus, the use of plain radiographs is more frequent, since it is sufficient for most cases (Mendes and Bahr Arias, 2012). The thoracolumbar and lumbosacral segments, more specifically from T9 to L7, represents an axis of greater predisposition to the occurrence of fractures or dislocations, since they suffer greater flexion pressure during trauma (Zotti et al., 2011). However, the total casuistry of vertebral fractures and dislocations, even for the canine species, was low, assuming that, due to the usefulness of radiography in the diagnosis of most of these injuries (Mendes

and Bahs Arias, 2012), tomography can be dispensed, although it is necessary in some cases.

In addition to traumatic changes, vertebrae can undergo genetic conformational alterations. Chondrodystrophic breeds are predisposed to the occurrence of vertebral malformations, such as hemivertebrae, block vertebrae, transitional vertebrae, spina bífida, among others. Such anatomical anomalies can be asymptomatic or predispose to the occurrence of neurological signs, by vertebral dislocation or spinal cord compression (Ryan et al., 2017; Bertram et al., 2019). Through statistical evaluation, in the presente study, the thoracolumbar region was the most affected by altered vertebral conformations, with the most frequent hemivertebrae. Confirming the bibliographic data, the Bulldog breeds, either English or French, were the most affected dog, reiterating the hypothesis that chondrodystrophic are more predisposed. The T10 vertebra was the second most affected, while the T10-11 intervertebral space was among the main ones for the occurrence of disk protrusion and mineralization, supporting the hypothesis that it is a facilitating agent for the occurrence of spinal cord injuries due to the instability generated. Furthermore, spina bífida and transitional vertebrae were identified, although in smaller proportions when related to hemivertebrae, while em bloc vertebrae were not observed.

Other aspects of vertebral deformities are related to neoplastic and non-neoplastic processes. Neoplasms can use signs through spinal cord compression, and their diagnosis, especially when it affects the spinal canal, is made through CT and MRI (Besalti et al., 2016). Such neoformations can be vertebral, meningeal, nervous tissue or even soft tissue origin, adjacent to the vertebrae (Besalti et al., 2016), and can also be metastatic, comming mainly from primary mammary tumor or dermal neoplasms (Valentim et al., 2016). Through statistical analyses, it was identified that for the thoracolumbar spine metastatic neoplasms were more frequent than primary ones, corroborating data from the literature (Valetim et al., 2016), while in the lumbosacral region vertebral primaries were more frequent than metastatic ones. Also, neoplastic alterations were among the main lesions identified in animals over nine years of age for the LS region and over 13 years for TL, indicating the predispostion of occurrence in older animals. The most commonly affected region is the thoracolumbar region (Valentim et al., 2016), a fact that was confirmed, since the total number of neoplastic involvement was higher for TL compared to LS.

Regarding non-neoplastic processes, the most frequent vertebral alteration identified was ventral spondylosis, being present among the main lesions for both regions evaluated. It was more frequently seen in chondrodystrophic or large animals, and was present in greater proportions in older patients in this study. Spondylosis is characterized as a non-inflammatory process of calcification of the ventral longitudinal ligament and intervertebral joints, resulting from vertebral instabilty and, therefore, may predispose to intervertebral disk diseases, although this alteration alone is not capable of causing clinical signs, being na incidental finding (Kranenburg et al., 2014). Proportionally to the other alterations, the LS region had more cases od spondylosis than the TL. Also, it was generally observed the concomitant involvement of disk mineralization and, in some cases, disk protrusion in the same sites involved by ventral spondylosis, which may support the hypothesis of predispostion to other disk lesions by instability.

Intervertebral disk diseases (IVDD) were the most frequently listed diseases in the list of tomographic diagnoses. One justification for this finding is the fact that CT and myelotomographic exams are more effective in diagnosing such changes than radiographic or myelographic exams (Costa et al., 2020). Although CT is better than radiography, MRI presents better diagnostic quality (Costa et al., 2020), however, for the geographical region where the study was conducted, CT represents the most advanced diagnostic imaging method commercially available. The most prominent IVDDs were: mineralization, disk extrusion and protrusion, for both regions evaluated, while the chondrodystrophic breeds figured as those of greater involvement.

The intervertebral disk has a rounded shape and is divided into: a hydrated nucleus pulposus in the center, a anulus fibrosus containing cartilaginous plates around it, and the transition zone, which corresponds to the meeting of both regions (Decker and Fenn, 2017). It may undergo a degeneration process, which can occur due to infectious causes, as in the case of discospondylitis, or due to anatomical and physiological factors. The latter cause is likely to occur in all animals, although chondrodystrophic breeds have a greater predisposition to suffer early degeneration (Klesty et al., 2019), a fact confirmed by the wide range of chondrodystrophic breeds in disk injuries, as well as greater appearance in younger age groupsaffected by intervertebral disk injuries. Mineralization was the main IVDD for the thoracolumbar region, while it figured as the second for the lumbosacral region, being an imaging change resulting from the process of disk degeneration that may predispose to other IVDDs that will lead to spinal cord compression (Decker and Fenn, 2017).

Disk extrusion and protrusion represent the IVDDs that most commonly cause clinical signs of myelopathies (Jeffery et al., 2013). According to this study, extrusion was more prevalent than protrusion for TL, while protrusion was more evident in the LS region compared to extrusion. The higher occurrence of thoracolumbar disk extrusion may be related, in part, to its predisposition to chondrodystrophic animals (Jeffery et al., 2013), since it was the most studied group of animals, as well as having greater vertebral anatomical changes that favor the process of instability and overloading of the intervertebral disk (Ryan et al., 2017; Bertram et al., 2019). Hansen I is the extrusion of the nucleus pulposus of the intervertebral disk, arising from a chondroid metaplasia and, therefore, is mostly related to chondrodystrophic dogs (Fenn et al., 2020), as seen for both study regions, although its occurrence has also been identified in non-chondrodystrophic patients, even if in smaller proportions. Hansen II, on the other hand, is characterized by the protrusion of the annulus fibrosus of the disk toward the spinal canal, which may or not cause spinal cord compression. This last disease is characterized by fibroid metaplasia, and is generally related to non-chondrodystrophic animals and older animals, and may or may not cause clinical signs (Marinho et al., 2014; Fenn et al., 2020). Through the data evaluated here, it was identified that the protrusion accurred mainly in chondrodystrophic animals for both regions evaluated, contrary to the data in the literature, in addition to the fact that for TL it was among the main changes only for animals over five years of age, while for LS it was already configured as the main alteration for animals under four years of age. Considering the three main IVDDs listed here, there is a tendency of occurrence in thoracolumbar transition sites, from T12 to L2, as well as in the lumbosacral transition, between L7

and S1. This fact, in addition to disk degeneration itself (Jeffery et al., 2013), may be related to instability generated by the vertebral anatomical variations at these sites, wheter normal or not, predisposing pressures in different locations of the disk and culminating in points of stress and injury. For example, through a previous study, it was identified that TL IVDDs have a greater predisposition to occur in vertebrae affected by dysplasia of the caudal process as a result of the stability alteration caused there (Nishida et al., 2019), corroborating the postulated hypothesis.

Another variation of IVDD is currently related. Hansen III is the extrusion of the nucleus pulposus into missile in a non-compressive manner, causing acute deep spinal cord injury (Decker and Fenn, 2017). Although CT is not the best diagnostic method for this change, it may be used for differentiation from other spinal cord compressive injuries (Decker and Fenn, 2017). Still, patterns of lesions similar to this pathological process have been identified for the TL region using myelotomography, characterizing a small number of lesions as Hansen III. The importance of knowledge of the appropriate imaging methods for each pathological alteration is essencial for clinical evaluation and decision making in the therapeutic management of the patient, especially when it comes to medullary syndromes referring to the thoracolumbar region, knowing that progressive myelomalacia is a complication likely to occur in acute intervertebral disk extrusions to this region, and may lead the animal to death (Castel et al., 2019), where agility in decision making establishes part of the prognostic factor.

Regarding the LS region, the IVDDs are strongly related to the cauda equina syndrome, also called lumbosacral stenosis. It affects mainly large breed animals and results in clinical signs of pain and neurological deficits related to nerve root compression, in short associated with the pelvic limbs and tail (Worth et al., 2019). Among the diagnostic methods, CT is applicable and may be sufficient to identify the possible causes of root compression, either by reduction of vertebral canal diameter by compression, or bv reduction of vertebral foramen diameter by tissue proliferation of foraminal disk extrusion/protrusion (Mukherjee et al., 2017; Worth et al., 2019). Based on the results reported here, the L7-S1 space was the most affected by diseases, mainly involving the intervertebral disk, and this may be one of the causes of said stenosis. Animals of large breeds were more frequently affected by this alteration in the age range of nine to twelve years, although in the younger age ranges, small and médium breeds were more frequent, indicating that the involvement by the syndrome may occur in other smaller animals, although the manifestation or not of clinical signs is variable and depends on the clinical and not imaging evaluation.

Conclusion

With the presente study, aimed at the thoracolumbar and lumbosacral spines, it was identified that the spin eis the main target of tomographic studies, besides the fact that the alterations related to the intervertebral disk are the main alterations identified in imaging studies of the spine, affecting middle-aged animals and the Franch Bulldog breed in their majority, reinforcing the chondrodystrophic predisposition. Still, it is expected that the demonstration of racial and age predisposition will be a guide to the clinician in decision making when requesting exams, as well as in the elaboration of the diferencial diagnosis chart for na agile and effective decision making for the patient.

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References

BERTRAM, S.; HAAR, G.T.; DECKER, S. Congenital malformations of the lumbosacral vertebral column are common in neurologically normal French Bulldogs, English Bulldogs, and Pugs, with breed specific differences. *Vet, Radiol. Ultrassound,* v. 60, n. 4, p. 400-408, 2019.

BESALTI, O.; CALISKAN, M.; CAN, P.; VURAL, S.A.; ALGIN, O.; AHLAT, O. Imaging and surgical outcomes of spinal tumors in 18 dogs and one cat. *J. Vet. Sci*., v. 17, n. 2, p.225-234, 2016.

CASTEL, A.; OLBY, N.J.; RU, H.; MARIANI, C.L.; MUÑANA, K.R.; EARLY, P. Risk factors associated with progressive myelomalacia in dogs with complete sensorimotor loss following intervertebral disc extrusion: a retrospective case-control study. *Bmc Vet. Res*., v. 15, n. 1, p. 1-9, 2019.

COSTA, R.C.; DECKER, S.; LEWIS, M.J.; VOLK, H.; THE CANINE SPINAL CORD INJURY CONSORTIUM. Diagnostic imaging in intervertebral disc disease. *Front. Vet. Sci.*, v. 7, n. 588338, p. 1-24, 2020.

COSTA, R.C.; MOORE, S.A. *Differential diagnosis of spinal diseases*. In: COSTA, R. C. (Ed.). Veterinary Clinics of North America: Small Animal Practice – Spinal disease. Philadelphia: Saunders Elsevier, 5 ed., 2010, p. 755-763.

DECKER, S.; FENN, J. Acute herniation of nondegenerate nucleus pulposus. *Vet. Clin. North Am. Small Anim. Pract.*, v. 48, n. 1, p. 95-109, 2017.

DECKER, S.; WARNER, A.S.; VOLK, H. Prevalence and breed predisposition for thoracolumbar intervertebral disc disease in cats. *J. Feline Med. Surg*., v. 19, n. 4, p. 419-423, 2016.

FENN, J.; OLBY, N.J.; THE CANINE SPINAL CORD INJURY CONSORTIUM. Classification of intervertebral disc disease. *Front. Vet. Sci*., v. 7, n. 579025, p. 1-17, 2020.

JEFFERY, N.D.; LEVINE, J.M.; OLBY, N. J.; STEIN, V.M. Intervertebral disk degeneration in dogs: consequences, diagnosis, treatment, and future directions. *J. Vet. Intern. Med.*, v. 27, n. 6, p.1318-1333, 2013.

KLESTY, A.; FORTERRE, F.; BOLLN, G. Postoperatives ergebnis bei diskopathien des hundes in abhängigkeit von rasse, lokalisation und erfahrung des chirurgen: 1113 fälle. *Tierarztl. Prax. Ausg. K. Kleintiere Heimtiere*, v. 47, n. 04, p. 233-241, 2019.

KRANENBURG, H.J.C.; HAZEWINKEL, H.A.W.; MEIJ, B.P. Naturally occurring spinal hyperostosis in dogs as a model for human spinal disorders. *Ilar J.*, v. 55, n. 1, p. 150-163, 2014.

MARINHO, P.V.T.; BAHR ARIAS, M.V.; ZANI, C.C.; MINTO, B.W. Doença do disco intervertebral Hansen tipo II em cães: fisiopatologia, abordagem clínico-cirúrgica e controvérsias. *Semin. Ciênc. Agrar.*, v. 35, n. 3, p.1395-1414, 2014.

MENDES, D.S.; BAHR ARIAS, M.V. Traumatismo da medula espinhal em cães e gatos: estudo prospectivo de 57 casos. *Pesq. Vet. Bras.*, v. 32, n. 12, p.1304-1312, 2012.

MUKHERJEE, M.; JONES, J.C.; HOLÁSKOVÁ, I.; RAYLMAN, R.; MEADE, J. Phenotyping of lumbosacral stenosis in Labrador retrievers using computed tomography. *Vet, Radiol. Ultrassound*, v. 58, n. 5, p. 565-580, 2017.

NISHIDA, H.; NAKATA, K.; MAEDA, S.; KAMISHINA, H. Prevalence and pattern of thoracolumbar caudal articular process anomalies and intervertebral disk herniations in pugs. *J. Vet. Med. Sci.*, v. 81, n. 6, p. 906-910, 2019.

RYAN, R.; GUTIERREZ-QUINTANA, R.; HAAR, G.T.; DECKER, S. Prevalence of thoracic vertebral malformations in French bulldogs, Pugs and English bulldogs with and without associated neurological deficits. *Vet. J.*, v. 221, p. 25-29, 2017.

SINGH, B. (Ed.). *Dyce Sack and Wensing's Textbook of Veterinary Anatomy*. Philadelphia: Saunders Elsevier, 5 ed., 2017, p. 1606.

VALENTIM, L.G.; MARCASSO, R.A.; BRACARENSE, A.P.F.L.; BAHR ARIAS, M.V. Spinal Neoplasm in Dogs. *Acta Sci. Vet.*, v. 44, n. 1, p.1-10, 2016.

WORTH, A.; MEIJ, B.; JEFFERY, N. Canine Degenerative Lumbosacral Stenosis: prevalence, impact and management strategies. *Vet. Med. Res. Rep.*, v. 10, p. 169-183, 2019.

ZOTTI, A.; GIANESELLA, M.; GASPARINETTI, N.; ZANETTI, E.; COZZI, B. A preliminary investigation of the relationship between the "moment of resistance" of the canine spine, and the frequency of traumatic vertebral lesions at different spinal levels. *Res. Vet. Sci.*, v. 90, n. 2, p. 179-184, 2011.