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Short communication

Prevalence, risk factors, and outcome of acute thoracic and lumbar myelopathies in non-chondrodystrophic dogs

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ABSTRACT

Acute thoracolumbar myelopathies are a common reason for consultation in veterinary neurology; however, the actual prevalence of the different diseases responsible for myelopathic signs in non-chondrodystrophic (NCD) dogs remains unknown. This retrospective, single-center study aimed to determine the prevalence and risk factors of diseases causing acute thoracic and lumbar myelopathies in NCD dogs. In addition, the relationship between prognostic factors, final diagnosis and neurological grade at admission was evaluated, with particular focus on mean time to improvement (MTI) and mean ambulatory recovery time (MART) among diagnostic groups. A total of 178 dogs presenting to the emergency service between 2014 and 2024 with clinical signs and a final diagnosis of thoracic or lumbar myelopathy were included. Dogs were classified according to final diagnosis into vascular (28/178–15.7%), inflammatory (25/178–14%), traumatic (49/178–27.5%), neoplastic (18/178–10.1%), or degenerative (58/178–32.6%) groups. For each group, statistical analyses were performed to identify epidemiological and clinical factors at presentation that could help clinicians in prioritizing differential diagnoses, including breed, sex, body weight, age, onset of clinical signs, neurological grade at presentation, progression of clinical signs, lesion localization, association with trauma or prior exercise, lateralization of clinical signs, and presence of spinal hyperesthesia. Degenerative intervertebral disk disease (IVDD) was the most frequently diagnosed condition in NCD dogs with acute myelopathy and primarily affected old, neutered dogs, with a higher prevalence in males and dogs weighing more than 25 kg. Most cases presented as chronic, non-lateralized myelopathies, often with acute worsening of clinical signs prior to presentation.

Introduction

Acute thoracic and lumbar myelopathies include diseases with different pathophysiological mechanisms. The prevalence and risk factors of different spinal diseases in non-chondrodystrophic (NCD) dogs with acute thoracolumbar myelopathies remain largely unknown as most studies usually evaluate specific disease conditions alone or include both chondrodystrophic (CD) and NCD dogs (Beltran et al., 2012; Bartholomew et al., 2016; Mari et al., 2017; Van Hoof et al., 2023; Alcoverro et al., 2024). Thus, the aim of this study was to retrospectively evaluate the prevalence and risk factors of different diseases that caused acute thoracic and lumbar myelopathies in NCD dogs diagnosed in our institution between 2014 and 2024. Furthermore, the relationship between prognostic factors, final diagnosis and neurological grade at admission was assessed.

Materials and methods

Inclusion criteria were: (a) dogs presented to the emergency service; (b) NCD dogs, according to the their phenotypic aspect and published prevalence of their CFA12 FGF4 and CFA18 FGF4 retrogenes expression (Parker et al., 2009; Dickinson and Bannasch, 2020), considering NCD all dogs with < 10% of both alleles' frequency (Agustini et al., 2024); (c) acute clinical signs and neurological examination consistent with a T3-L3 or L4-S3 myelopathy; (d) complete medical records (hematology, serum biochemistry, thoracic radiographs, abdominal ultrasound and magnetic resonance imaging (MRI) of the spine).

Exclusion criteria included: (a) cross breed dogs; (b) dogs without neurological deficits on initial neurological examination; (c) dogs with motor deficits but with a final diagnosis of non-neurological disease (arterial thromboembolism, generalized weakness secondary to

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systemic condition, orthopedic disease, etc.).

Data collected from the medical records included breed, age, sex, neuter status, bodyweight, onset and progression of clinical signs, neurological grade, presence of spinal hyperesthesia, lateralization of clinical signs, spinal cord segments affected, presence of suspected spinal shock, physical activity at the onset of clinical signs, final diagnosis and outcome.

Onset of clinical signs was categorized as peracute, acute, subacute or chronic. Cases were classified as progressive when clinical signs had been present during the 48 h preceding neurological deterioration and hospital admission. Neurological status was graded as (1) ambulatory paraparetic, (2) non-ambulatory paraparetic, (3) non-ambulatory paraparetic with monoplegia of one pelvic limb, (4) paraplegic and (5) paraplegic without deep pain perception (DPP). Spinal shock was suspected in dogs with reduced spinal reflexes in the pelvic limbs and no abnormalities in the L4-S3 spinal cord segments on MRI (Smith and Jeffery, 2005).

Final diagnoses were classified using the VITAMIND mnemonic (vascular, inflammatory/infectious, anomalous, metabolic, idiopathic, neoplastic and degenerative) according to the underlying pathophysiology (Da Costa and Moore, 2010).

To evaluate outcome, a minimum follow-up of 30 days after diagnosis was required for the descriptive analysis. This study only included data from rechecks performed at the authors' hospital by the neurology service. Outcome was graded as excellent (no neurological deficits were detected on last recheck), good (ambulatory but there were residual deficits on neurological examination) and poor (the patient did not regain ambulation). Mean time to improvement (MTI) was defined as the mean duration from admission to the first documented improvement of at least one neurological grade relative to the neurological status at admission. Mean ambulatory recovery time (MART) was defined as the mean time required for animals that were non-ambulatory on initial presentation to regain independent ambulation. These measures may assist clinicians in providing owners with realistic expectations regarding the course of recovery based on the underlying disease and the neurological grade at admission.

Statistical analysis was performed using SPSS Statistics version 26 (IBM Corporation, Armonk, New York, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were summarized as absolute frequencies and percentages. Normality and homogeneity of variances were assessed before analysis. Parametric (Student's *t*-test and one-way ANOVA) and non-parametric (Mann-Whitney *U* test or Kruskal-Wallis) were used as appropriate. Categorical variables were evaluated using the Chi-square test or Fisher's exact test and the crude odds ratios (OR) with their corresponding 95% confidence intervals (95% CI) were calculated to estimate the strength of association. All statistical tests were two-tailed, and statistical significance was set at $p < 0.05$.

Results and discussion

A total of 178 dogs of various breeds were included in the study (supplemental table 1). Mean age at presentation was 7.5 ± 3.1 (range 1–15) years. Mean weight was 28.1 kg ± 11.4 (range 3.5–80). Both variables showed normal distribution ($p > 0.05$). Descriptive data about signalment and risk factors for each disease group are summarize in supplemental table 2.

Concerning the outcome, 18 dogs were excluded from the study due to lack of follow-up. Twenty-one dogs were euthanized: 18 right after diagnosis and the other 3 dogs at 2, 30 and 35 days after diagnosis due to lack of clinical improvement. A total of 141 dogs were evaluated for prognosis.

Clinical features that were statistically significant for each disease group and descriptive data about the outcome are detailed below and summarized in Table 1 and Table 2, respectively.

As previously reported by Da Costa and Moore (2010) in a heterogenous canine population, we found that degenerative, traumatic, vascular, inflammatory and neoplastic diseases accounted for most diagnoses.

Degenerative spinal diseases were the most common (58/178–32.6%) and degenerative intervertebral disc disease (IVDD) was the most prevalent in this group (57/58–98.3%), with only one degenerative myelopathy (DM) case (1.7%). Among the degenerative IVDD cases, 31/58 (53.4%) were intervertebral disc extrusions (IVDE), 16/58 (27.6%) acute on chronic intervertebral disc herniations (acIVDH), 6/31 (19.4%) disc-associated extensive epidural hemorrhages (DEEH) and 10/58 (17.2%) intervertebral disc protrusions (IVDP). Although it has been long assumed that degenerative IVDD differs between CD and NCD dogs, the high prevalence of IVDE and acIVDH observed in this study supports recent histopathological findings suggesting that intervertebral disc degeneration in both phenotypes is characterized by chondroid metaplasia of the nucleus pulposus (Hansen et al., 2017). In NCD breeds, the replacement of notochordal cells by chondrocyte-like cells seems to occur later in life (Hansen et al., 2017), which may explain the higher percentage of dogs over 7 years of age in this group (46/58–79.3%; $p < 0.001$).

Degenerative conditions were generally observed as chronic (17/58–29.3%; $p < 0.05$), non-lateralized (35/58–60.3%; $p < 0.034$) myelopathies, frequently followed by an acute worsening of clinical signs before presentation (23/29–79.3%; $p < 0.001$) without association with physical activity (11/58–19%; $p < 0.007$). Lesions were predominantly located in the T3-L3 region (55/58–94.8%; $p < 0.001$). Distribution of degenerative diseases across the different disc spaces is summarized in Fig. 1. Most dogs were ambulatory paraparetic (grade 1) on admission (34/58–58.6%; $p < 0.001$).

Of the 45 dogs with degenerative disease in which prognosis was evaluated, 31 (68.9%) had good outcomes, while 7 dogs (15.6%) had excellent outcome and 7 dogs (15.6%) had a poor outcome. The MTI was 14.6 days (range 1–180 days), and the MART was 39.4 days (range 2–180 days). Further information regarding MTI and MART according to neurological grade for degenerative diseases is available in supplemental table 3. Forty-nine percent (22/45) of cases experienced deterioration in neurological status, with a mean time to deterioration of 2.1 days (range 0.5–30 days). Fifteen dogs worsened right after surgery. Of these, 3 cases were associated with hematoma formation at the surgical site within the first 24–48 h post-surgery. The remaining 7 dogs deteriorated before diagnosis in 6 cases and after diagnosis due to progression of degenerative disease in 1 case (DM case). However, 17 dogs of the 22 that initially worsened eventually improved.

Decompressive surgery was performed in 77.8% of cases, and the mean follow-up period for this group was 118.17 days (range 15–1006 days).

Disk degeneration may also be linked to non-compressive disorders, especially vascular lesions such as fibrocartilaginous embolic myelopathy (FCEM), as the material responsible for the spinal cord ischemia is histologically indistinguishable from degenerated nucleus pulposus (Cauzinille and Kornegay, 1996). Vascular lesions were identified in 28/178 dogs (15.7%), and they were all presumed FCEM based on imaging features. Overall, they were characterized by a peracute onset (19/28–67.9%; $p < 0.001$), non-progressive course ($p < 0.008$) and non-painful clinical signs (24/28–85.7%; $p < 0.001$). The most common presentation was non-ambulatory paraparesis with monoplegia of one pelvic limb (grade 3: 12/28–42.9%; $p < 0.006$).

The overall recovery rate of dogs with FCEM was 84%, like descriptions in previous reports (De Risio et al., 2007). The MTI after diagnosis was 7.56 days (range 1–30 days), and the MART was 20.4 days (range 1–70 days). The MTI and MART values for each neurological grade on admission in dogs with a final diagnosis of presumed FCEM are detailed in supplemental table 4. Contrary to previous studies stating that no paraplegic dogs without DPP regained independent ambulation and that only one-third of paraplegic dogs with DPP recovered the ability to walk independently (De Risio et al., 2008), in our study

Table 1
Results of univariable logistic regression analysis evaluating associations between clinical features for each disease group (n = 178).

DG	BREED	SEX	WEIGHT	AGE	ONSET	NG[a]	PROGRESSION	LOCALIZATION	PLAY/ TRAUMA	LATERALIZATION	HYPERESTHESIA
V (28/ 178)					Peracute $p < 0.001$ OR: 4.22 (1.782–10.005)	Grade 3 $p < 0.006$ OR: 3.235 (1.353–7.734)	Non progressive $p < 0.008$ OR: 0.288 (0.11–0.75)				Non-painful $p < 0.001$ OR: 0.19 (0.063–0.576)
I (25/178)					Chronic *1–2 weeks* $p < 0.005$ OR: 4.516 (1.474–13.834) *> 2 weeks* $p < 0.001$ OR: 5.175 (1.952–13.721)		Progressive $p < 0.001$ OR: 4.908 (1.854–12.994)			Non-lateralized $p < 0.007$ OR: 0.295 (0.116–0.748)	Painful $p < 0.001$ OR: 4.454 (1.752–11.322)
T (48/ 178)	AST $p < 0.04$ OR: 2.678 1.016–7.057)	Females $p < 0.034$ OR: 2.379 (1.054–5.369)		Younger $p <$ 0.001 U: 1727 Z: −4.68	Peracute $p < 0.001$ OR: 6.985 (3.356–14.541)	Grade 3 $p < 0.001$ OR: 6.693 (3.037–14.753)	Non-progressive $p < 0.001$ OR: 0.107 (0.043–0.269)		Associated $p < 0.001$ OR: 13.469 (6.157–29.463)	Lateralized $p < 0.001$ OR: 3.39 (1.64–6.984)	
N (18/ 178)	LR $p < 0.027$ OR: 3.462 (1.092–10.971)		Larger $p < 0.005$ OR: 11.041 (1.43–85.047)		Chronic *1–2 weeks* $p < 0.003$ OR: 5.21 (1.57–17.288)	Grade 2 $p < 0.001$ OR: 4.632 (1.698–12.641)					
D (58/ 178)				Older $p < 0.001$ U: 1819.5 Z: −5.173	Chronic *> 2 weeks* $p < 0.05$ OR: 2.348 (0.982–5.612)	Grade 1 $p < 0.001$ OR: 3.896 (2.012–7.544)	Progressive $p < 0.001$ OR: 2.93 (1.532–5.605)	T3-L3 $p < 0.001$ OR: 5.204 (2.182–12.414)	Non-associated $p < 0.007$ OR: 0.364 (0.171–0.771)	Non-lateralized $p < 0.034$ OR: 1.98 (1.05–3.74)	

Note: Results displayed are only those that were statistically significant ($p < 0.05$) following a manual backwards stepwise removal approach. Values are OR (95% CI).
Abbreviations: AST, American Staffordshire Terrier; D, degenerative; DG, disease group; I, inflammatory; LR, Labrador Retriever; N, neoplasia; NG, neurological grade; T, traumatic; V, vascular.
[a]Neurological grade: Grade 1, ambulatory paraparetic; Grade 2, non-ambulatory paraparetic; Grade 3, non-ambulatory paraparetic with monoplegia; Grade 4, paraplegic; Grade 5, paraplegic without deep pain perception.

Table 2
Summary of outcome data for different disease group (n = 141).

	V (25/141)	I (22/141)	T (45/141)	N (4/141)	D (45/141)
Outcome					
Excellent	8 (32%)	15 (68.2%)	15 (33.3%)	0	7 (15.6%)
Good	13 (52%)	5 (22.7%)	27 (60%)	3 (75%)	31 (68.9%)
Poor	4 (16%)	2 (9.1%)	3 (6.7%)	1 (25%)	7 (15.6%)
Euthanasia	2 (7.4%)	3 (12%)	1 (2.2%)	12 (75%)	4 (8.3%)
Improvement after diagnosis	25 (100%)	20 (91%)	44 (97.8%)	3 (75%)	35 (77.8%)
Time to improvement after diagnosis*	7.6 (1–30)	9.3 (1–30)	5.5 (1–30)	6.8 (2–14)	14.6 (1–180)
Deterioration after diagnosis	2 (8%)	3 (13.6%)	5 (11.1%)	4 (100%)	22 (48.9%)
Time to deterioration after diagnosis*	1	2.3 (1–4)	1.8 (1–3)	75.5 (1–240)	2.1 (0.5–30)
Time for recovery of ambulation after diagnosis*	20.4 (1–70)	13.8 (3–60)	15.8 (1–60)	7.5 (1–14)	39.4 (2–180)
Surgery	0	1 (4.5%)	2 (4.4%)	3 (75%)	35 (77.8%)
Follow-up time*	129.8 (30–1460)	219.5 (40–540)	72.8 (30–240)	100 (15–240)	118.2 (15–1006)

Abbreviations: D, degenerative; I, inflammatory; N, neoplasia; T, traumatic; V, vascular.
*The time of this measure is expressed in days

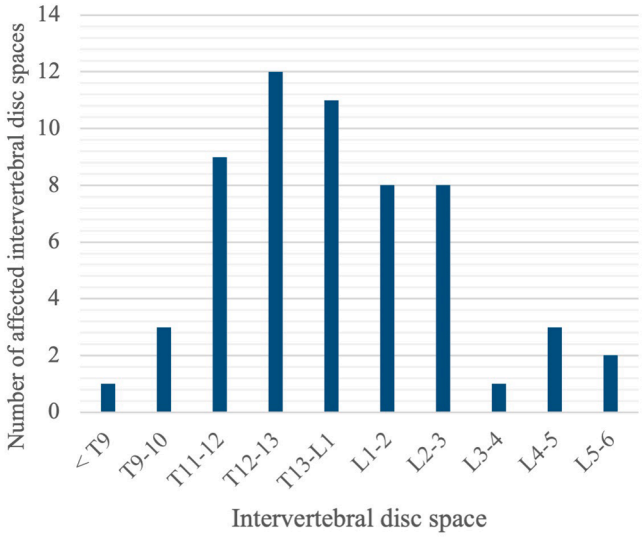


Fig. 1. Frequency of diagnosis of degenerative disease by anatomic location. X-axis indicates the intervertebral disc space. Y-axis indicates the total number of affected intervertebral disc spaces.

one-third of paraplegic patients without DPP and all paraplegic dogs with DPP recovered the ability to walk independently. However, there were 4 dogs (16%) with a poor outcome: three were unable to walk independently and one dog required amputation of the affected limb due to self-mutilation. Two cases (8%) deteriorated within the first 24 h following diagnosis.

Traumatic spinal injuries were identified in 49/178 dogs (27.5%). Acute non-compressive nucleus pulposus extrusion (ANNPE) was the most frequent diagnosis (39/49–79.6%), followed by hydrated nucleus pulposus extrusion (HNPE) (7/49–14.3%), traumatic hemorrhage or hematoma (2/49–4%), and vertebral subluxation (1/49–2%). American Staffordshire Terriers were significantly overrepresented (9/49–18.37%; $p < 0.04$), as well as females (23/49–47%; $p < 0.034$). Young dogs (< 7 years) were also more commonly affected (33/49–67.3%; $p < 0.001$).

Most traumatic cases were associated with a recent history of trauma or intense physical activity (36/49–73.5%; $p < 0.001$), and the clinical presentation was peracute in onset (35/49–71.4%; $p < 0.001$), non-progressive ($p < 0.001$), and lateralized (36/49–73.5%; $p < 0.001$). The most common presentation was non-ambulatory paraparesis with monoplegia of a pelvic limb (22/49–44.9%; $p < 0.001$).

As previously reported by Mari et al. (2017), traumatic cases showed a high improvement rate (97.8%), although residual deficits were frequent (27/45–60%) on last recheck. Three dogs (6.7%) with a final diagnosis of ANNPE were considered to have a poor prognosis, as one was euthanized 35 days later due to persistent paraplegia with negative DPP, and the other two lost DPP at 24 and 72 h after admission and were unable to walk independently 70 days post-discharge. In addition, three more patients worsened during the first 24–72 h but regained ambulation at 3, 13, and 60 days. Overall, the MTI was 5.52 days (range 1–30 days), and the MART was 16.8 days (range 1–60 days) after diagnosis. MTI and MART values according to neurological grade on admission for this category are detailed in supplemental table 5.

Inflammatory spinal cord diseases were identified in 25/178 dogs (14%), and discospondylitis (DS) was the most common diagnosis (21/25–84%). Among the dogs with DS, 12/21 (57.1%) had secondary disc extrusion, 8/21 (38.1%) had associated epidural empyema and 1/21 (4.8%) had vertebral subluxation. These concurrent abnormalities may have contributed to the neurological deficits observed in these dogs. Additionally, 19/21 (90.5%) of the affected dogs showed concurrent presumed paravertebral myositis on MRI. As previously documented, neurological deficits in DS cases were most frequently localized in the T3-L3 spinal cord segments (15/21–71.4%) but the most commonly affected site was L7-S1 (7/21, 33.3%) (Burkert et al., 2005; Harris et al., 2013; Van Hoof et al., 2023). Lumbosacral lesions would not be expected to directly affect the spinal cord. In these cases, the associated epidural empyema and extension of the inflammatory process affecting adjacent neural structures may have resulted in involvement of the cranial spinal cord segments and cauda equina and nerve roots, thereby contributing to the neurological deficits observed. Additionally, 4 dogs (19%) had multiple affected intervertebral disc spaces. Fig. 2 shows the number of affected intervertebral disc spaces at each spinal location.

Less frequent etiologies included primary empyema without DS (1/25–4%), lumbar ganglioneuritis (1/25–4%), and infectious

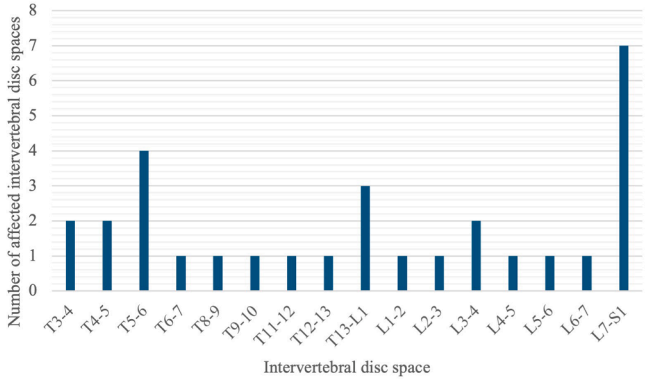


Fig. 2. Number of dogs with discospondylitis (DS) at different affected discs. X-axis indicates the intervertebral disc space. Y-axis indicates the total number of affected intervertebral disc spaces.

meningomyelitis (MM) (2/25–8%). Clinically, inflammatory myelopathies were predominantly chronic (15/25–60%; 1–2 weeks: $p < 0.005$; >2 weeks: $p < 0.001$), progressive (19/25–86.4%; $p < 0.001$), painful (18/25–72%; $p < 0.001$) and caused symmetric neurological deficits (18/25–72%; $p < 0.007$). Contrary to earlier studies, we did not find any significant association with sex or neuter status (Burkert et al., 2005).

In this category, 91% of patients showed improvement and 68.2% achieved an excellent outcome. Residual motor deficits were observed in 22.7% (5/22) of dogs. The MTI was 9.3 days (range 1–30 days), and the MART was around 13.8 days (range 3–60 days) after diagnosis. However, 9% (2/22) of dogs were unable to walk independently at 40 and 90 days after discharge. Data about MTI and MART are summarized in supplemental table 6. Three dogs (13.6%) experienced worsening of clinical signs within 2.3 days (range 1–4 days) after diagnosis and only one improved after treatment. Interestingly, the only case that improved post-treatment was one in which microbiological cultures were negative. In contrast, the remaining 2 dogs had positive cultures for *Staphylococcus pseudintermedius*, *Corynebacterium* and alpha-hemolytic *Streptococcus*. Fungal cultures were not performed in any of the three refractory cases.

Neoplastic spinal conditions were identified in 18/178 dogs (10.1%). Extradural tumors were the most prevalent (14/18–77.8%), and bone involvement was present in most cases (10/14–71.4%), with an equal distribution between monostotic and polyostotic tumors (5/14–35.7% each).

Large breed (17/18–94.4%; $p < 0.005$) dogs were more likely to have a final diagnosis of neoplasia, particularly Labrador Retrievers ($p < 0.027$; OR: 3.462) but without a clear breed predisposition for specific neoplastic subtypes as previously reported in other breeds (Liebel et al., 2011; Dobson, 2013). Most cases presented with chronic clinical signs (8/18–44.4%; $p < 0.003$) and the most frequently observed neurological grade was 2 (10/18–55.6%; $p < 0.001$). A definitive diagnosis was established in 7 cases (38.9%): three through surgical biopsies, two via fine-needle aspiration (FNA) and two following necropsy.

Dogs in this group had the highest euthanasia rate (12/16–75%), with all non-ambulatory dogs being euthanized at the time of diagnosis and therefore excluded from the outcome analysis. Of the 4 remaining dogs, 3 (75%) initially improved, but residual motor deficits remained. The MTI after diagnosis was 6.8 days (range 2–14 days) and the MART was 7.5 days (range 1–14 days), but all dogs deteriorated in a median period of 75.5 days (range 1–240 days). Additional data on MTI and MART by neurological grade for this group are summarized in supplemental table 7. The median follow-up time was 100 days (range 15–240 days).

The limitations of this study arise from its retrospective nature, because the presence or absence of certain clinical features may not be accurately documented in all the medical records. Additionally, the lack of a definitive histopathological diagnosis restricts the strength of the conclusions, requiring generalizations made for groups of cases rather than for individual patients. Another limitation is the inclusion criterion requiring MRI, which may influence the reported incidence rates, as other imaging modalities were also commonly used to diagnose some spinal conditions.

Another important limitation of this study is that only animals presenting with neurological deficits to the emergency service were included. This criterion may particularly impact the representation of diseases with a chronic and insidious course, which can initially present with vague or non-specific clinical signs, such as pain or fever.

Finally, HNPE and ANNPE were classified within the traumatic group. Although previous studies have shown that the extruded nucleus pulposus may exhibit partial degenerative changes (Falzone, 2017), these changes largely overlap with the physiological age-related alterations of the intervertebral disc (Bergknut et al., 2013). In the present study, these conditions were classified as traumatic disorders based on their characteristic clinical presentation and presumed triggering mechanism, as they were typically associated with minor trauma or vigorous physical activity in previous studies (De Risio et al., 2009; Beltran et al., 2012; De Decker and Fenn, 2018; Alcoverro et al., 2024). Consequently, this methodological decision should be taken into account when comparing our findings with those of studies adopting alternative classification systems.

In summary, this study provides valuable insight into the epidemiology, clinical presentation, and outcome of thoracic and lumbar spinal cord diseases of acute presentation in a large cohort of pure breed NCD dogs. Understanding the differences on presentation, as well as identifying epidemiological risk factors, may aid clinicians to elaborate a differential diagnosis list and develop appropriate and individualized diagnostic work up plans. Furthermore, this article provides a review of the prognosis associated with different diseases. In contrast to what is commonly believed, the most frequently diagnosed condition in NCD dogs with signs of acute myelopathy is degenerative IVDD, similar to what happens in CD breeds. However, information obtained from the neurological examination, as well as the breed or age, can help refine the diagnosis and prioritize other conditions.

Ethics declaration

This study was conducted in accordance with the ARRIVE (Animal Research: Reporting of In Vivo Experiments) guidelines. Ethics committee approval was not required. This is a retrospective study of clinical cases, no experiments were carried out

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Declaration of Competing Interest

None of the authors of this article has a financial or personal relationships with other people or organizations that could inappropriately influence or bias the content of the paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.tvjl.2026.106871.

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