

# Journal of the Hellenic Veterinary Medical Society

Vol 74, No 1 (2023)



## Clinical and epidemiological profiles and outcome of non-traumatic myelopathies in dogs

*RD Baka, S Balla, GM Kazakos, MN Patsikas, ZS Polizopoulou*

doi: [10.12681/jhvms.29415](https://doi.org/10.12681/jhvms.29415)

Copyright © 2023, Rania Baka, Sofia Mpala, George Kazakos, Michail Patsikas, Zoe Polizopoulou



This work is licensed under a [Creative Commons Attribution-NonCommercial 4.0](https://creativecommons.org/licenses/by-nc/4.0/).

### To cite this article:

Baka, R., Balla, S., Kazakos, G., Patsikas, M., & Polizopoulou, Z. (2023). Clinical and epidemiological profiles and outcome of non-traumatic myelopathies in dogs. *Journal of the Hellenic Veterinary Medical Society*, 74(1), 5335–5344. <https://doi.org/10.12681/jhvms.29415> (Original work published April 11, 2023)

## Clinical and epidemiological profiles and outcome of non-traumatic myelopathies in dogs

R.D. Baka<sup>1</sup> , S. Balla<sup>2</sup>, G.M. Kazakos<sup>2</sup> , M.N. Patsikas<sup>3</sup> , Z.S. Polizopoulou<sup>1</sup> 

<sup>1</sup> Diagnostic Laboratory, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

<sup>2</sup> Companion Animal Clinic, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

<sup>3</sup> Laboratory of Diagnostic Imaging, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece

**ABSTRACT:** Myelopathies, the disorders affecting the spinal cord, are classified into traumatic or non-traumatic. In dogs, intervertebral disc disease (IVD) is the most common cause of spinal pain and neurological deficits. The aim of the current study was to present the prevalence, clinical presentation, diagnosis and outcome of non-traumatic myelopathies of various etiologies, in dogs. This was a retrospective study in dogs. The inclusion criteria for the dog population included complete clinical records of the cases (physical, neurological examination, clinicopathological and/or diagnostic imaging), therapy, outcome and re-examinations. A total of 618 dogs were included in the study with a mean age of 6 years and a mean body weight of 12kg. The neurological deficits appeared acutely in 346 dogs (56%). Paraplegia (201/618, 32.5%), paraparesis (144/618, 23.3%) were the most frequent neurological deficits, followed by spinal pain (61/618, 9.9%). In the majority of cases, the lesions (374/618, 60.5%) were localized in the thoracolumbar spinal cord segments. Degenerative disc disease was the predominant diagnosis in the study population (212 dogs, 62.5%), followed by neoplasia (10%), congenital anomalies (6.2%), myelitis (5.9%) and, less frequently, discospondylitis (4.1%), caudal cervical spondylomyelopathy (3.8%) and meningitis (3%). There were few cases with extradural synovial cysts (2.1%), congenital myelopathies (1.2%), Chiari-like malformation (0.9%). Regarding outcome, 476/618 (77%) dogs were alive at the end of the study. From the 476 dogs that were still alive, 278/476 dogs (58.4%) improved neurologically, 120/476 dogs (25.2%) were neurologically stable, 22/476 dogs (4.6%) deteriorated. Degenerative disc disease was the most common diagnosis in dogs admitted with paraparesis/ paraplegia. Myelography could diagnose secondary spinal compression caused by disc protrusion/ extrusion or any other cause. Corticosteroids and non-steroidal anti-inflammatory drugs (NSAID) were used commonly by the referring veterinarian in case a compressive myelopathy was suspected. Prognosis in dogs with degenerative disc disease type II is favorable when therapy was started soon after the clinical sign's onset and the deep pain sensation was intact.

**Key words:** degenerative disc disease; epidemiological profile; dog; non-traumatic myelopathies; outcome

*Corresponding Author:*

Rania D. Baka, 11, St. Voutyra str., 54627 Thessaloniki, Greece  
Diagnostic Laboratory, School of Veterinary Medicine, Faculty of Health Sciences,  
Aristotle University of Thessaloniki, Thessaloniki, Greece  
E-mail address: raniadbaka@gmail.com

*Date of initial submission: 30-01-2022*  
*Date of acceptance: 14-11-2022*

## INTRODUCTION

Myelopathies, the disorders of the spinal cord, can be classified into traumatic or non-traumatic (New et al., 2013). The clinical signs associated with spinal cord dysfunction depend on the location, size and the rate of lesion development (Dewey, 2008a). In humans, it is reported that the incidence of non-traumatic myelopathies in developed countries is greater than that of traumatic myelopathies, although much more research has been conducted involving traumatic myelopathies (New and Sundararajan, 2008; Noon et al., 2012; New et al., 2013).

In dogs, intervertebral disc disease (IVD) is the most common cause of spinal pain and neurological deficits (Parent, 2010). Intervertebral disc disease is more common in chondrodystrophic breeds and should not be diagnosed in any dog younger than 2 years of age without a spinal diagnostic imaging workup (Parent, 2010).

Primary or metastatic tumors of the vertebral canal and its content remain a consideration in older dogs (Parent, 2010). Spinal neoplasia involves the spinal cord, dura, exiting peripheral nerves, or paraspinal tissues (vertebrae and ligaments) and results in clinical signs of spinal cord dysfunction (Bagley, 2010).

Multiple genetic breed-specific disorders associated with spinal cord disease have been recorded in dogs (Dewey, 2008b). These include degenerative myelopathy, leukoencephalomyelopathies, leukodystrophies, axonopathies (Da Costa and Cook, 2016; Dewey, 2008b). Synovial cysts belong to probable genetic spinal disorders since their accurate pathogenesis is not well-known. Therefore, the probable genetic basis of the disease exists since all dogs diagnosed with synovial cysts have simultaneously other degenerative spinal diseases (e.g. synovial cysts of the cervical region of the spinal cord were diagnosed in dogs with cervical spondylomyelopathy) (Lawrie et al., 2014).

Lesion localization is the most important part in diagnosing neurologic diseases (Parent, 2010). Therefore, the neurological examination should always be carried out in its entirety (Parent, 2010). Many patients with vertebral column pain have no other neurological examination abnormality and may still have significant spinal cord disease (Morgan et al., 1993; Sukhiani et al., 1996). Upon completion of the neurological examination, precise lesion localization greatly facilitates clinical interpretation (Parent, 2010).

The list of differential diagnosis is compiled based on animal's signalment, history, lesion localization, presence/absence of vertebral pain, and presence/absence of systemic signs (Parent, 2010).

Vertebral and spinal cord disorders are the most common causes of chronic pain (Bell et al., 2014). Chronic pain attributed to the nervous system damage may be particularly challenging to treat, since the pain is frequently neuropathic in origin (Mathews, 2008; Rusbridge and Jeffery, 2008).

The aim of the current study was to present the prevalence, clinical presentation, diagnosis and outcome of non-traumatic myelopathies of various etiologies in dogs.

## MATERIALS AND METHODS

This was a retrospective study of dogs, admitted at the Companion Animal Clinic, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki from January 2007 to December 2017. The inclusion criteria for the dog population included complete clinical records of the cases (physical, neurological examination, clinicopathological and/or diagnostic imaging investigation). Cases in which definite diagnosis was not established were also included in the study, if according to the records there was follow up communication (via phone call or e-mail) with the owner. Dogs with incomplete case records or with the diagnosis of traumatic myelopathy were excluded from the study. Dogs that were not admitted for re-examination/-s or their owners did not respond to the phone-calls, were incomplete cases and were excluded from the study.

The case records were reviewed regarding the epidemiological data (breed, gender, body weight, and lifestyle of the dogs). History including the cause for admission, the duration of neurological signs, the time interval from the onset of neurological signs until admission, medication from the referring veterinarian, physical and neurological examination findings, neuroanatomical lesion localization, concurrent diseases, clinicopathological and/or diagnostic imaging (upon available) findings, cerebrospinal fluid (CSF) analysis, diagnosis, treatment, re-examinations and outcome were recorded.

The dogs were further categorized based on their body weight and breed as miniature ( $\leq 3$ kg), small (3-10kg), medium (10-25kg), large (25-45kg) and giant ( $>45$ kg). Mixed-breed dogs were categorized as small

( $\leq 10$ kg), medium (10-25kg) and large (25-45) based on their body weight.

The duration of neurological signs were further classified as acute ( $< 24$ h), sub-acute (1-7 days) and chronic ( $> 7$  days). The time interval from the onset of neurological signs since admission were recorded as immediate (within 24h), within 24-48h, within 2-5 days, and  $> 5$  days. The anatomical localization of the lesions was established after physical and neurological examination was performed and included the cervical (C1-C5 spinal cord segments), cervico-thoracic (C6-T2 spinal cord segments), thoracolumbar (T3-L3 spinal cord segments), lumbosacral (L4-S3 spinal cord segments) regions of the spinal cord.

Routine clinicopathological evaluation included complete blood counts (CBC), serum biochemistry and urinalysis. Regarding serum biochemistry, it involved assessment of hepatic, renal function and electrolytes. Diagnostic imaging, when available, included spinal radiographs, myelography, computed tomography (CT), and CT-myelography or magnetic resonance imaging (MRI). Cerebrospinal fluid collection was performed either via cisternal magna or lumbar tap, depending on the proximity of the lesion to the collection site. Cerebrospinal fluid analysis included total nucleated cell count (TNCC), measurement of total protein concentration and cytological examination.

Treatment was recorded as symptomatic or etiological. Symptomatic treatment involved medical therapy and/or nursing care and/or physiotherapy. Regarding the re-examinations, they included either the re-evaluation of the clinical/neurological status of cases or the communication with the owner when re-admission of the dogs to the clinic was not possible. Outcome was recorded as death/ euthanasia or as

alive. For the cases that were alive at the time of the last follow-up, improvement, stability or worsening/relapse was also recorded.

### Statistical analysis

All descriptive statistics were performed using SPSS 19.0. The *Shapiro-Wilk* (S-W) test for normality was used to examine, whether the continuous variables followed the normal distribution. The S-W test for normality revealed that all continuous parameters did not follow the normal distribution, and minimum (*min*), maximum (*max*) and median (*Mdn*) values of the parameters were provided. The non-continuous parameters were provided as percentages.

## RESULTS

From the total number of 12.648 dogs admitted at the Companion Animal Clinic, School of Veterinary Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, from January 2007 to December 2017, 758 were admitted for non-traumatic myelopathies of various etiologies (6%). Of those, 140 (18.4%) did not meet the inclusion criteria and were excluded from the study. A total of 618 dogs were finally included in the current study. The mean age of the study population was 6 years, ranging from 1 month to 19 years old. The mean body weight was 12 kg (min: 1Kg, max: 56Kg).

Based on the breed combined with their body weight, the study population was separated as purebred and mixed-breed dogs. Table 1 includes the study population dogs separated based on their body weight and the breed that they belonged. Table 2 presents the breeds of the study population dogs.

Regarding the living conditions, 413 dogs (66.8%) were living indoors, 143 (23.1%) were living outdoors, 48 (7.8%) shared both indoor and outdoor en-

**Table 1.** Number of purebred and mixed-breed dogs of the study population.

Purebred dogs	Number (Total: 618)	Percentage (%)
Miniature	15	2,4
Small	202	32,7
Medium	140	22,7
Large	108	17,5
Giant	14	2,3
<b>Mixed breed dogs</b>		
Small	54	8,7
Medium	61	9,9
Large	24	3,9

**Table 2.** Study population breeds of dogs.

<b>Breed</b>	<b>Number (Total: 618)</b>	<b>Percentage (%)</b>
Mixed breed	143	23,1
Pekingese	51	8,2
French Bulldog	50	8
German Shepherd	45	7,3
Miniature Poodle	42	6,8
Rottweiler	36	5,8
Maltese	27	4,4
Cocker Spaniel	26	4,2
Dachshund	19	3,1
Miniature Pinscher	18	2,9
Shih-tzu	13	2,1
Beagle	12	1,9
Boxer	12	1,9
Yorkshire Terrier	11	1,8
Hellenic hound	10	1,6
Labrador Retriever	9	1,5
Doberman	8	1,3
Pitbull	8	1,3
Siberian Husky	6	1
Pug	5	0,8
Jack Russell Terrier	5	0,8
Dalmatian	5	0,8
Hellenic Shepherd	4	0,6
Malinois	4	0,6
Sharpei	4	0,6
Collie	4	0,6
English Pointer	3	0,5
Great Dane	3	0,5
Caucasian	3	0,5
Pomeranian	3	0,5
Cavalier King Charles Spaniel	3	0,5
Chihuahua	3	0,5
Canadian Shepherd	3	0,5
Belgian Shepherd	2	0,3
German shorthair pointer	2	0,3
Brittany Spaniel	2	0,3
English Bulldog	2	0,3
English Setter	2	0,3
Dogo Argentino	1	0,2
Greyhound	1	0,2
Bichon Frise	1	0,2
West Highland White Terrier	1	0,2
Cane Corso	1	0,2
Clumber Spaniel	1	0,2
Fox Terrier	1	0,2
Whippet	1	0,2
Dogue de Bordeaux	1	0,2
Hungarian Vizsla	1	0,2

vironment and 14 (2.3%) were stray dogs.

The neurological deficits appeared acutely in 346 dogs (56%), sub-acutely in 116 dogs (18.8%) and 156 dogs (25.2%) suffered from chronic neurological deficits on admission. The time interval from the onset of clinical signs was <24 hours in 13 dogs (2.1%). Thirty seven dogs (6%) had been admitted after 24-48 hours from the onset of clinical signs. Sixty-six dogs (10.7%) were admitted after 2-5 days from the onset of clinical signs and the vast majority of the study population dogs (502/618) (81.2%) were admitted after 5 days from the onset of the neurological deficits. The cause for admission was the neurological dysfunction in 351 dogs (56.8%) and almost equal cases (267/618, 43.2%) were admitted after their owners observed improvement of the neurological deficits of their pets.

Medication (proposed by the referring veterinarians) was administered in 462/618 dogs (74.8%) the day admitted to the clinic. Medication included steroids combined with other drugs in 320/462 dogs (69.3%), non-steroid anti-inflammatory drugs (NSAID) alongside with other drugs in 171/462 dogs (37%), steroids

as monotherapy in 210/462 dogs (45.5%), NSAID as monotherapy in 85/462 dogs (18.4%). Other drugs included antibiotics, diazepam, gabapentin and opioids in 168/462 dogs (36.4%).

The concurrent diseases of the study population dogs were summarized in Table 3. More than half of the study population did not have any concurrent disease.

The neurological deficits that were identified on admission, based on history, were mentioned in Table 4. After the neurological examination was completed, there was spinal pain in 77 dogs (12.5%), neurological deficits in one or more limbs in 554 dogs (89.6%) and in 64 dogs (10.4%) neurological examination was unremarkable. Neurological lameness was seen in 23 (3.7%) and hypometria in 15 dogs (2.4%), respectively. Pain was the only symptom in 61 dogs (9.9%) however pain was identified along with other neurological deficits in 125 dogs (20.2%). Myelopathy signs were asymmetrical in 39 dogs (6.3%). There was concurrent encephalopathy in 64 (10.4%) and myoclonus in 15 dogs (2.4%). Myelopathy was severe (grade IV/V)

**Table 3.** Concurrent diseases of the study population dogs.

Concurrent Disease	Number (Total: 618)	Percentage (%)
None identified	351	56,8
Orthopedic	54	8,7
Dermatological	52	8,4
Gastrointestinal	39	6,3
Other neurological dysfunction	36	5,5
Infectious Diseases	24	3,9
Ocular	22	3,6
Respiratory	12	1,9
Urinary- Genital	12	1,9
Endocrinological	10	1,6
Heart Diseases	7	1,1
Extraneural neoplasia	1	0,2

**Table 4.** Neurological deficits identified in the study population dogs on admission.

Neurological deficits on admission	Number (Total: 618)	Percentage (%)
Paraplegia	201	32,5
Paraparesis	144	23,3
Spinal pain	61	9,9
Tetraplegia	43	6,9
Ataxia	38	6,2
Tetraparesis	31	5,1
Monoplegia	8	3,1
Paresis of forelimbs	3	0,5
Hemiplegia	2	0,3
Combination of neurological signs	87	12,2

in 107 cases (16.5%) since 73 dogs (11.8%) had loss of deep pain sensation and 29 (4.7%) had hypoesthesia. From the 73 dogs with loss of deep pain sensation, 40 dogs were diagnosed with disc disease (14 dogs with type I disc disease, 16 dogs with type II disc disease and 10 with non compressive disc disease), 6 dogs had neoplasia involving either the vertebrae or neural tissue, 4 dogs had discospondylitis, 6 dogs ischemic myelopathy and 3 dogs congenital (vertebral) anomalies. From the 29 dogs with hypoesthesia, 18 dogs were diagnosed with disc disease (9 dogs with type I disc disease, 6 dogs with type II disc disease and 3 dogs with non compressive disc disease), 3 dogs with ischemic myelopathy, 3 dogs with vertebral/neural neoplasia, 1 dog with congenital anomaly (hemivertebra) and 1 dog with discospondylitis. There were micriturition disorders in 5 dogs: 3 dogs (0.5%) had urinary retention (upper motor neuron (UMN) bladder) and 2 dogs (0.3%) had urinary incontinence (lower motor neuron (LMN) bladder). The localization of spinal cord lesions in the study population is summarized in Table 5. Most of the dogs' lesions (374/618, 60.5%) were localized in the thoracolumbar spinal cord segments.

Diagnostic imaging included the plain radiographs

of the spine in 307 (49.7%), myelography in 345 (55.8%), computed tomography (CT) in 44 (7.1%) and magnetic resonance imaging in 63 dogs (10.2%). Definite diagnosis was established in 199/307 dogs (64.8%) based on radiological examination. Myelography established definite diagnosis in 266/345 dogs (77.1%), CT in 34/44 dogs (77.3%) and MRI in 57/63 dogs (90.5%). Twenty dogs underwent biopsy from mass lesions of the spine or from vertebral lesions indicative of discospondylitis.

In seventeen cases a definite diagnosis was established following the histopathological examination of biopsies. Bacterial culture was performed in fourteen biopsy specimens (14/618, 2.2%) and was positive in all samples, thus contributing to the diagnosis.

Cerebrospinal fluid analysis (CSF) was performed in 63/618 dogs (10.2%). Of those, 32/63 samples were normal (10.2%), 26/63 were abnormal (41.3%) and 5/63 (7.9%) samples were discarded due to a traumatic tap. Necropsy was performed in seven dogs and established the final diagnosis in all cases.

Diagnosis of myelopathies in the study population included etiological diagnosis in 339/618 dogs (54.8%) (Table 6) and presumptive diagnosis in

**Table 5.** Lesion localization of study population dogs.

Lesion localization- myelopathy	Number (Total: 618)	Percentage (%)
Thoracolumbar	374	60,5
Cervical	126	20,4
Cervicothoracic	55	8,9
Lumbosacral	49	7,9
Multifocal	14	2,3

**Table 6.** Definite diagnosis of the study population dogs.

Diagnosis	Number (Total:339)	Percentage (%)
<b>Degenerative Disc Disease</b>	212	62,5
<i>Type I extrusion</i>	160/212	
<i>Type II protrusion</i>	25/212	
<i>Non compressive</i>	27/212	
<b>Neoplasia</b>	34	10
<b>Congenital anomalous</b>	21	6,2
<b>Myelitis</b>	20	5,9
<b>Discospondylitis</b>	14	4,1
<b>Caudal cervical spondylomyelopathy</b>	13	3,8
<b>Meningitis</b>	10	3
<b>Extradural Synovial Cysts</b>	7	2,1
<b>Congenital myelopathy</b>	4	1,2
<b>Chiari-like malformation</b>	3	0,9
<b>Acquired syringomyelia</b>	1	0,3

182/618 dogs (29.4%). In 97 cases no diagnosis could be set (15.7%).

Ninety-six dogs did not receive any treatment (15.5%), whereas 211/618 (34.2%) underwent etiological and 311/618 (50.3%) symptomatic therapy.

Regarding the outcome, 476/618 (77%) dogs were alive at the end of the study, 99/618 (16%) died or were euthanized. From the 476 dogs that were still alive by the end of the study, 278/476 dogs (58.4%) improved, 120/476 dogs (25.2%) were neurologically stable, 22/476 dogs (4.6%) deteriorated.

## DISCUSSION

The results of the current study demonstrated that most myelopathies had an acute onset (346/618, 56%). Most dogs were presented clinically with paraplegia (201/618, 32.5%), followed by paraparesis (144/618, 23.3%). In accordance to that, the anatomical localization more commonly affected, was the thoracolumbar region of the spinal cord (thoracolumbar syndrome) (374/618, 60.5%).

Half of the study population dogs (316/618, 51.1%) were diagnosed with spinal compression secondary to degenerative disc disease. Degenerative disc disease with acute disc herniation causing spinal cord injury is common in canine patients, especially in chondrodystrophic breeds which are predisposed to the disease (Fletcher and Dewey, 2003; Vitale and Coates, 2007). Similar to what is reported, 33% of the study population dogs belonged to small-breeds, lived indoors (66.8%) and were admitted with neurological signs of acute myelopathy (56%).

Regarding to the site of disk extrusion, the results of the current study are comparable to those reported in the literature (Dewey, 2008). Therefore, disc extrusion commonly involved disk spaced T11-L4, indicating that the thoracolumbar region is affected more frequently compared to the cervical part of the spine. The latter was affected less frequently in this study and findings were recorded in both cranial and caudal cervical disk spaces in near equal number of cases (13 cases with cervical spondylopathy, 10 cases with cervical disc extrusion and 37 with cervical disc protrusion). Conversely, in the literature, it is reported that the C2-C3 intervertebral space was the most common site of disk extrusion in the cervical region (Dewey, 2008). Regarding disk extrusion, the anatomical site of the damage was the same and caudal thoracic-cranial lumbar disk spaces were commonly affected.

Both cranial and caudal cervical regions and less frequently caudal lumbar region of the spinal cord were affected by disk protrusions. Regarding to the severity of the spinal injury, the results of the current study indicated that acute spinal cord injury (usually seen in type I and non compressive disc disease) is associated with a more severe myelopathy (loss of deep pain sensation/hypoesthesia), which is in agreement with the relevant literature (Dewey, 2008).

Radiological examination of the spine was the only diagnostic test performed in 199/307 dogs (64.8%) and it was able to establish diagnosis in the current study. Routine survey radiographs are always recommended before proceeding with advanced imaging, since the area of interest may be more specifically localized, reducing scanning time and severe spinal/ osseous lesions, such as vertebral malformations or discospondylitis, may be identified without the need of advanced imaging (Da Costa and Samii, 2010). The diagnosis of these 199 dogs based solely on survey radiographs included vertebral neoplasia, congenital vertebral malformations and anomalies, calcified disc herniations (disc protrusion), and discospondylitis. Due to the high incidence of IVD in Dachshunds, a scheme for radiological scoring of intervertebral disc calcification has been development (Rosenblatt et al., 2014; Rosenblatt et al., 2018). Although more advanced imaging diagnostic tests are available (CT or MRI), there is no reliable scoring system in CT/MRI, capable to replace the radiological scoring in Dachshunds with intervertebral disc calcification (Rosenblatt et al., 2018). In the current study, there were 19 Dachshunds; all of them underwent radiological examination of the spinal cord combined with other advanced diagnostic imaging tests (myelography, CT, MRI). All nineteen Dachshunds were diagnosed with degenerative disc disease (type I, II or non compressive). Fifteen Dachshunds presented signs of the thoracolumbar syndrome and nine had compressive myelopathy due to disc protrusion. The most common site of disc protrusion in the thoracolumbar spinal cord was T12-T13 disc space (6 dogs), followed by T13-L1 disc space (4 dogs). A previous study demonstrated an association between neuter status and diagnosis of disc disease in both male and female Dachshund populations, indicating that early neutering/castration of dogs can predispose to diseases and weight gain (as a complication of neutering/castration) may be a predisposing factor for disc disease (Dorn and Seath, 2018). On the contrary, the results of the current study indicated that 18/19



Dachshunds that diagnosed with disc disease were intact (11/19 male intact, 7/19 female intact). Only one Dachshund was female neutered. Possible explanations for the different results were the small number of cases of the current study which could not reliably represent the Dachshund population of the area where the study was conducted. Although the small number of cases was a restricting factor for safe conclusions, the data of this study could reflect that the neutering program applied after the age of 12 months old of the dogs did not affect the incidence of disc disease in this breed.

Corticosteroids, either as monotherapy (45.5%) or combined with other medication (gabapentin, opioids, diazepam, antibiotics) (69.3%) were usually administered on admission by the referring veterinarians, followed by non-steroidal anti-inflammatory drugs (NSAID) monotherapy (18.4%) or combined with other medication (gabapentin, opioids, diazepam, antibiotics) (37%). Despite their controversial benefits on acute spinal injury, corticosteroids remain popular in the medical management of myelopathies (Park et al., 2012). Although management of acute spinal injury could be challenging, early onset of treatment improved the patient outcome (Park et al., 2012). Despite the late admission to the clinic (>5 days after the onset of the neurological dysfunction), 77% of the dogs were alive at the time of the last follow up, and 58.4% of them improved neurologically. The early onset of medical management could be associated with a more favorable outcome, in agreement with published data (Park et al., 2012).

Myelography was the most commonly used advanced diagnostic imaging test in the current study (345/618, 55.8%), establishing a definite diagnosis in 266 dogs (266/345, 77.1%). Myelography was combined with survey radiographs in the vast majority of the cases for better lesion localization. Degenerative disc disease type I and type II were diagnosed with myelography; non compressive degenerative disc disease was diagnosed less frequently. In degenerative disc disease type II, myelography could highlight the asymmetric spinal cord compression. Discospondylitis, congenital vertebral anomalies and vertebral neoplasia with secondary spinal compression were diagnosed with myelography combined with plain spinal radiographs, but less frequently. Spinal arachnoid diverticulas, intramedullary neoplasms, cervical spondylopathy and intradural-extramedullary neoplasms were also diagnosed with myelography in the current

study in a small number of cases (in total 54 cases). It is known that myelography is a sensitive imaging method for diagnosis of spinal compression, as it was proved by the results of the current study; however its limitations and technical difficulties are well known and can be overcome by more advanced diagnostic imaging techniques (eg. CT/MRI) (Dennison et al., 2010).

Computed tomography-myelography was performed in 29 cases, contributing mainly in the diagnosis of compressive myelopathy caused by disc protrusion/extrusion, and less frequently neoplasia and discospondylitis. Computed tomography is a more sensitive imaging technique for localizing disc extrusions and when combined with myelography, was shown to yield high sensitivity with the highest confidence score for disc disease (Newcomb et al., 2012). CT-myelography confirmed the positional relationship between the spinal cord and the protruded disc, and helped in planning the surgical techniques for cervical and thoracolumbar disc disease in dogs (Hara et al., 1994; Israel et al., 2009). Due to the high sensitivity of the CT-myelography, it has indicated excellent prognosis for the surgical cases (precise lesion localization and spinal cord decompression) (Hara et al., 1994; Israel et al., 2009).

Other advanced diagnostic imaging tests (CT, MRI) were performed less frequently. Although they have higher sensitivity and specificity in detecting the lesions of the vertebral column/spinal cord, they were not used frequently due to financial constraints. Computed tomography was performed in 44 (7.1%) and MRI in 63 (10.2%) dogs, proven to be diagnostic in 34 (77.3%) and 57 (90.5%) cases, respectively. The overall sensitivity of MRI is superior to CT and MRI is used to image the vast majority of spinal disorders, with few exceptions (spinal trauma caused by gunshot) (Da Costa and Samii, 2010). MRI performed in the dogs of the current study, established definite diagnosis in all cases, which included degenerative disc disease (types I, II, non compressive), intramedullary and intradural-extramedullary neoplasms, spinal gliosis, neuroaxonal dystrophy, discospondylitis, syringomyelia, spinal arachnoid diverticula, fibrocartilaginous embolic myelopathy and meningitis/myelitis.

Fibrocartilaginous embolic myelopathy is another acute onset myelopathy and was diagnosed in only 4.4% of the dogs in the current study. The caudal thoracic spinal cord segments were the most commonly

affected area, contrary to what has been reported and indicating the caudal lumbar part as the most frequent lesion site (Lorenz and Kornegay, 2004).

Almost half of the dogs (311/618, 50.3%) received symptomatic treatment and most of them improved clinically (58.4%) or remained stable neurologically (25.2%). Success rates reported by others for medical management of ambulatory dogs ranged from 55.6-100% (Davies and Sharp, 1983; Olby et al., 2004; Levine et al., 2007).

There were few cases of Chiari-like malformation accompanied with syringomyelia. All dogs belonged to the Cavalier King Charles Spaniel breed, which is predisposed to this condition (Rusbridge et al., 2000; Rusbridge et al., 2006). All cases had severe neurological signs, indicative of cervical myelopathy. Despite the severe neurological signs, none of the dogs developed epileptic seizures, as reported in some cases previously (Rusbridge et al., 2000). Only one dog was euthanized due to severe neurological symptoms. The other two cases were treated to control neuropathic pain (gabapentin, pregabalin +/- glucocorticoids) and improved although their neurological signs persisted to a lesser degree of severity. Despite surgical decompression of the foramen magnum was proposed, owners declined, after they were informed about the guarded prognosis.

Intramedullary neoplasms were detected infrequently in the current study. As reported in the literature, intramedullary tumors occur less commonly and usually affect the cervical spinal cord (Pancotto et al., 2013). Metastatic spinal cord tumors were found infrequently as well. As expected, most of the cases with intramedullary spinal tumors died or were euthanized, because of the poor prognosis due to the tumor location (Pancotto et al., 2013). The metastatic intramedullary tumor, secondary to primary hepatic neoplasia was associated with thoracolumbar syndrome signs and the dog was euthanized soon after diagnosis was established. Interestingly, equal numbers of dogs with intradural-extramedullary tumors were died/euthanized and were still alive at the time of writing. Clinical signs usually deteriorate progres-

sively; MRI is the diagnostic tool of choice (Besalti et al., 2016). Old, large breed dogs are susceptible to develop spinal tumors, although younger dogs may have a tendency to develop tumors of neural origin as well (Heyman et al., 1992; Liebel et al., 2011; Pancotto et al., 2013). Surgical resection is performed in epidural and intradural-extramedullary spinal tumors according to the surgical outcomes, which depend on tumor type and malignancy (Besalti et al., 2016). The prognosis depends on the degree of local resection, degree of spinal infiltration, spinal cord damage before and during surgery, surgeon's experience and tumor type (Bagley, 2010).

### LIMITATIONS OF THE STUDY

The retrospective nature of the study was the main limitation. Most non-traumatic melopathies were diagnosed based on myelography instead of advanced diagnosing imaging (CT/MRI) indicating that accurate location and characterization of the spinal damage may be lost. Since re-admission of the dogs to the clinic for a neurological re-evaluation was not possible in some cases, contact via phone-calls was performed. The data collected via phone-calls regarding the outcome were based solely on owner's perspective which in fact was subjective, biased opinions. Lastly, administration of treatment on admission, which was not an exclusion criterion for the population study, may influence the neurological status of the dogs, therefore it could influence the findings of the neurological examination of the population.

### CONCLUSIONS

Degenerative disc disease was the most common diagnosis in dogs admitted with paraparesis/paraplegia. Myelography could diagnose secondary spinal compression caused by disc protrusion/extrusion or any other cause. Corticosteroids and non-steroidal anti-inflammatory drugs (NSAID) were used commonly by the referring veterinarians in case a compressive myelopathy was suspected. Prognosis in dogs with degenerative disc disease type was favorable when therapy was started soon after the onset of clinical signs and the deep pain sensation was intact.

## REFERENCES

- Bagley RS (2010) Spinal neoplasms in small animals. *Vet Clin North Am Small Anim Pract* 40: 915-927.
- Bell A, Helm J, Reid J (2014) Veterinarians' attitudes to chronic pain in dogs. *Vet Rec* 175 (17): 428. DOI: 10.1136/vr.102352.
- Besalti O, Caliskan M, Can P, Vural SA, Algin O, Ahlat O (2016) Imaging and surgical outcomes of spinal tumors in 18 dogs and one cat. *J Vet Sci* 17 (2): 225-234.
- Da Costa RC, Samii VF (2010) Advanced imaging of the spine in small animals. *Vet Clin Small Anim* 40: 765-790.
- Da Costa RC, Cook LB (2016) Cystic abnormalities of the spinal cord and vertebral column. *Vet Clin Small Anim* 46: 277-293.
- Davies JV, Sharp NJH (1983) A comparison of conservative treatment and fenestration for thoracolumbar intervertebral disc disease in the dog. *J Small Anim Pract* 24:721-729.
- Dennison SE, Drees R, Rylander H, Yandell BS, Milovancev M, Pettigrew R, Schwarz T (2010) Evaluation of different computed tomography techniques and myelography for the diagnosis of acute canine myelopathy. *Vet Radiol Ultrasound* 51(3): 254-258.
- Dewey CW (2008) Myelopathies: Disorders of the spinal cord. In: A practical guide to canine and feline neurology. 2<sup>nd</sup>ed, Wiley-Blackwell, Ames pp 323-388.
- Dewey CW, Bailey KS (2008) Signalment, history, and the differential diagnosis: the first consideration. In: A practical guide to canine and feline neurology. 2<sup>nd</sup>ed, Wiley-Blackwell, Ames pp 4-14. (b)
- Dorn M, Seath IJ (2018) Neuter status as a risk factor for canine intervertebral disc herniation (IVDH) in dachshunds: a retrospective cohort study. *Canine Genet Epidemiol* 15 (5): 11.
- Fletcher DJ, Dewey CW (2003) Spinal trauma management. In: Practical guide to canine and feline neurology. Iowa State University Press, Ames pp405-417.
- Hara Y, Tagawa M, Ejima H, Orima H, Fujita M (1994) Usefulness of computed tomography after myelography for surgery on dogs with cervical intervertebral disc protrusion. *J Vet Med Sci* 56 (4): 791-794.
- Heyman SJ, Diefenerfer DL, Goldschmidt MH, Newton CD (1992) Canine axial skeletal osteosarcoma: a retrospective study of 116 cases (1986 to 1989). *Vet Surg* 21: 304-310.
- Israel SK, Levine JM, Kerwin SC, Levine GJ, Fosgate GT (2009) The relative sensitivity of computed tomography and myelography for identification of thoracolumbar intervertebral disc herniations in dogs. *Vet Radiol Ultrasound* 50 (3): 247-252.
- Lawrie ML, Platt SR, Garosi LS (2014) Extramedullary spinal cysts in dogs. *Vet Surg* 43 (6): 650-662.
- Levine JM, Levine GJ, Johnson SI, Kerwin SC, Hettlich BF, Fosgate GT (2007) Evaluation of the success of medical management for presumptive thoracolumbar intervertebral disc herniation in dogs. *Vet Surg* 36: 482-491.
- Liebel FX, Rossmeisl JH Jr, Lanz OI, Robertson JL (2011) Canine spinal nephroblastoma: long-term outcome associated with treatment of 10 cases (1996-2009). *Vet Surg* 40: 244-252.
- Lorenz MD, Komegay JN (2004) Pelvic limb paresis, paralysis, or ataxia. In: Handbook of Veterinary Neurology, 4<sup>th</sup>ed, Saunders, St. Louis pp 131-174.
- Mathews KA (2008) Neuropathic pain in dogs and cats: if only they could tell us if they hurt. *Vet Clinics North Am Small Anim Pract* 38: 1365-1414.
- Morgan PW, Parent JM, Holmberg DL (1993) Cervical pain secondary to intervertebral disc disease in dogs: radiographic findings and surgical implications. *Prog Vet Neurol* 4: 76-80.
- New PW, Sundararajan V (2008) Incidence of non-traumatic spinal cord injury in Victoria, Australia: a population-based study and literature review. *Spinal Cord* 46:406-411.
- New PW, Farry A, Baxter D, Noonan VK (2013) Prevalence of non-traumatic spinal cord injury in Victoria, Australia. *Spinal Cord* 51: 99-102.
- Newcomb B, Arble J, Rochat M, Pechman R, Payton M (2012) Comparison of computed tomography and myelography to a reference standard of computed tomographic myelography for evaluation of dogs with intervertebral disc disease. *Vet Surg* 41 (2): 207-214.
- Noonan VK, Fingas M, Farry A, Baxter D, Singh A, Fehlings MG, Dvorak MF (2012) The incidence and prevalence of SCI in Canada: a national perspective. *Neuroepidemiology* 38: 219-226.
- Olby N, Harris T, Burr J, Munna K, Sharp N, Keene B (2004) Recovery of pelvic limb function in dogs following acute intervertebral disc herniations. *J Neurotrauma* 21: 49-59.
- Pancotto TE, Rossneisl JH Jr, Zimmerman K, Robertson JL, Were SR (2013) Intramedullary spinal cord neoplasia in 53 dogs (1990-2010): distribution, clinicopathological characteristics, and clinical behavior. *J Vet Intern Med* 27: 1500-1508.
- Park E, White GA, Tieber LM (2012) Mechanisms of injury and emergency care of acute spinal cord injury in dogs and cats. *J Vet Emerg Crit Care* 22(2): 160-178.
- Rosenblatt AJ, Bottema CD, Hill PB (2014) Radiographic scoring for intervertebral disc calcification in the Dachshund. *Vet J* 200: 355-361.
- Rusbridge C, Jeffery ND (2008) Pathophysiology and treatment of neuropathic pain associated with syringomyelia. *Vet J* 175: 164-172.
- Sukhiani HR, Parent JM, Atilola MA, Holmberg DL (1996) Intervertebral disc disease in dogs with signs of back pain alone: 25 cases (1986-1993). *J Am Vet Med Assoc* 209: 1275-1279.
- Vitale C, Coates J (2007) Acute spinal cord injury. *Stand care: Emerg Crit Care Med* 9.7: 1-11.