

# Neurological disorders in dogs and cats and their physiotherapy: incidence, genetic predisposition, recovery

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**Abstract.** The present work aimed to present the incidence of some neurological diseases in dogs and cats, identifying cases of genetic predisposition in some breeds, and their recovering by physiotherapy. Investigations were conducted on 2765 dogs and cats. Of these, 89 individuals were diagnosed with neurological disorders which required physiotherapy. Considering the specie and sex of individuals who showed neurological disorders that required physiotherapy, 70 of them were dogs (78.65%) and 19, cats (21.35%). In the case of dogs, 41 were males (58.57%) and 29 females (41.43%), and for cats, 6 were males (31.58%) and 13 females (68.42%). Neurological disorders (that required physiotherapy) diagnosed during this study were spinal disorders and nerve root disorders. Two categories of spinal diseases were found in our study, traumatic and degenerative. Among the nerve root disorders, brachial plexus avulsion was the only found. Their incidence varied among specie, sex, and breed, according to the nature of the produced event or as a genetic predisposition. In many cases the prognosis of such cases is reserved in terms of total recovery, physiotherapy procedures finding their usefulness when they are started early and the animal owners work with the physiotherapist to perform daily sessions.

**Key Words:** spinal cord & peripheral nerve disorders, electrostimulation, ultrasound therapy

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## Introduction

Neurological disorders are an important group of medical conditions whose symptoms impress through paresis and paralysis, abnormal postures, impaired muscle tonus, proprioception and reflectivity, with progressive deterioration of animal's life quality (Bagley, 1997). A comprehensive classification of neurological conditions requiring physiotherapy, depending on their localization, includes: (i) Spinal cord disorders: traumatic (fractures, dislocations and subluxations), degenerative (disc herniations, deforming spondylosis), vascular (fibrocartilaginous embolism, medullary infarction), abnormalities (hemivertebra, spinal fusion or welding of vertebrae); (ii) Nerve root disorders: polyradiculoneuritis; (iii) Peripheral neuropathy or peripheral nerve disorders: brachial plexus avulsion (reviewed by Henea 2020). There are different causes of neurological disorders, congenital factors, traumatic pathologies or those of infectious nature (often viral) being often incriminated (DiFazio and Fletcher 2013; Passantino and Masucci, 2016). Their therapeutic is complex, usually interdisciplinary, with attack and supportive protocol including neurosthenics and anti-inflammatory drugs, which may be associated or not with surgical treatment. In addition, physiotherapy is a recovery therapeutic procedure whose principles and techniques are personalized applied to the patient's pathology and its needs, in order to facilitate its body maintenance in anatomical position (Kline, 2002). The effectiveness of physiotherapy depends on the injuries' severity, type of applied

procedures and the number of sessions, satisfactory results being reported under the strict adherence by the owners on the therapeutic protocol established by the attending veterinarian. The aim of this paper is to present the incidence of some neurological diseases in dogs and cats, identifying cases of genetic predisposition in some breeds, and their recovering by physiotherapy. The paper presents numerous aspects of originality in terms of classifying neurological diseases of interest in pet carnivores and establishing the incidence of each of their type considering various criteria of diagnostic.

## Materials and Methods

Investigations were conducted on a total of 2765 individuals who came for medical evaluation in the Medical Clinic of the Faculty of Veterinary Medicine of Iași during December 2018 and until now (21 months of study). Of these, 89 individuals were diagnosed with neurological disorders which required physiotherapy. In order to accomplish this, there were used: clinical examination (general semiological methods), neurological examination (assessing the behavior, postures and spinal reflexes) and, in some cases, radiological, ultrasound and paraclinical blood investigations. The investigated cases were centralized and the incidence of various neurological diseases was differentially established according to specie, sex, age and breed.

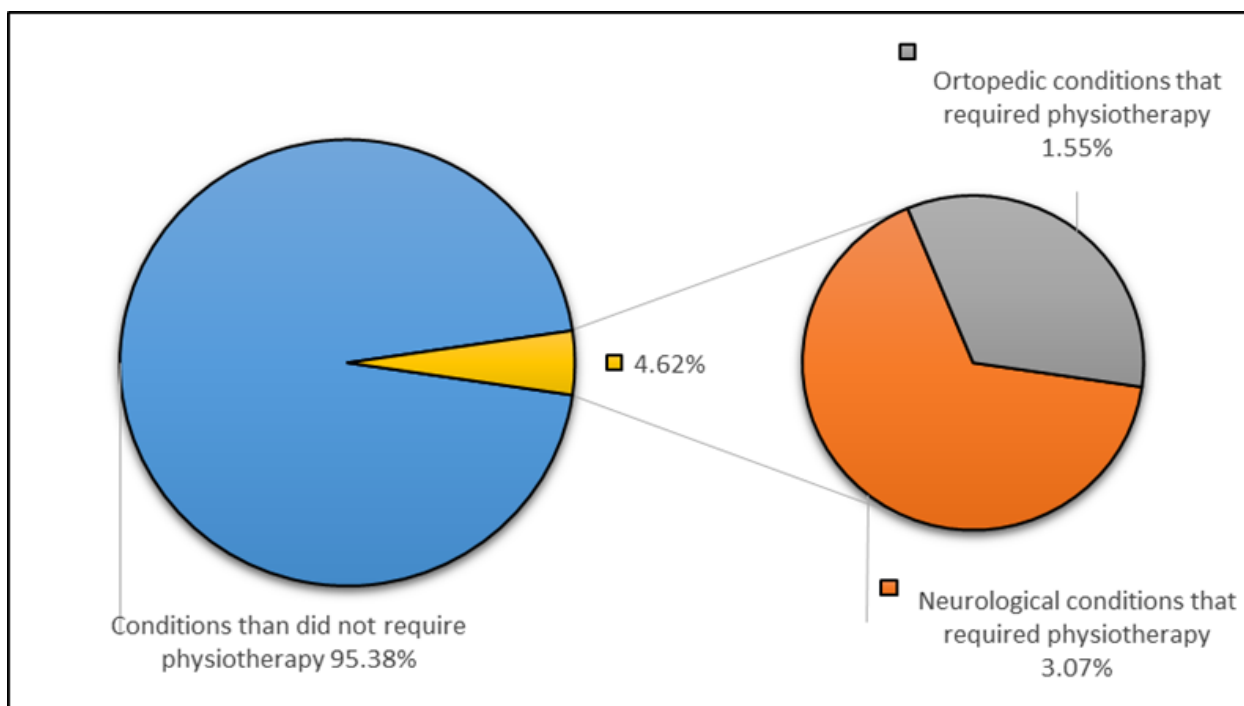


Fig.1: Major types of investigated cases during the study period

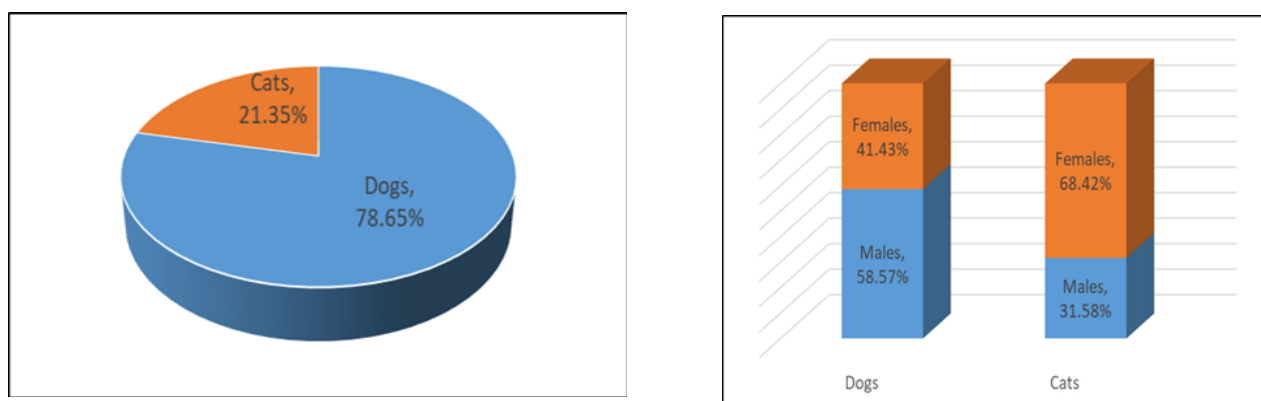


Fig.2: The incidence of neurological disorders that required physiotherapy by specie and sex

## Results

The results of the medical investigations on a total number of 2765 cases in a period of 21 months showed that of these, 134 (4.62%) were diseases that required physiotherapy, 89 (3.07% of the total) being neurological diseases and 45 (1.55% of the total), orthopedic cases (Figure 1). Reported to the number of cases that required physiotherapy, neurological disorders accounted for the majority (66.42%).

Neurological disorders (that required physiotherapy) diagnosed during this study were spinal disorders and nerve root disorders. Out of the total of 86 cases with spinal disorders (96.63% of all cases with neurological disorders), 68 were dogs (79.07% of all cases with spinal disorders), of which 40 males (58.82%) and 28 females (41.18%), and 18 were cats (20.93% of all cases with spinal disorders), of which 5 males (27.78%) and 13 females (72.22%). Nerve root disorders were found in 3 cases (3.37% of all cases with neurological disorders), 2 dogs (66.67%) and one cat (33.33%), the two dogs being one male and the other female, and the cat being male. Two categories of spinal diseases were found in our study, traumatic and degenerative. The 21 cases of traumatic spinal disorders (24.42% of

all cases with spinal disorders) were found in 11 dogs (52.38% of the cases of traumatic spinal disorders) and 10 cats (47.62% of the cases of traumatic spinal disorders), the 11 dogs including 6 males (54.55%) and 5 females (45.45%), while all cats with traumatic spinal disorders were females. Degenerative spinal disorders were found in 65 cases (75.58% of all cases of spinal disorders), of which 57 dogs (87.69% of all cases of degenerative spinal disorders) and 8 cats (12.31% of all cases of degenerative spinal disorders). The distribution of degenerative spinal diseases by sex showed, in the case of dogs, the affecting of 34 males (59.65%) and 23 females (40.35%), and in the case of cats, 5 males (62.5%) and 3 females (37.5%). Among the nerve root disorders, brachial plexus avulsion was found in 3 cases (3.37% of all cases with neurological disorders), affecting 2 dogs (66.67% of cases with nerve root disorders) and a cat (33.33% of the cases with nerve root disorders). The two affected dogs were one male and the other female, and the cat was a male (Table 1).

Among traumatic spinal disorders diagnosed in the investigated cases, the following ones can be listed: thoraco-lumbar spine fracture (11 cases; 52.38% of all traumatic spinal diseases),

Table 1. The incidence of orthopedic diseases that required physiotherapy depending on specie and sex

Conditions that required physiotherapy	Types	Subtypes	Dogs				Cats				Total #
			Males		Females		Males		Females		
			#	%	#	%	#	%	#	%	
Neurological disorders	Spinal disorders	Traumatic spinal disorders	6	54.55	5	45.45	-	-	10	100	86
		Total #	11		10						
		Degenerative spinal disorders	34	59.65	23	40.35	5	62.5	3	37.5	
	Total #	57		8						89	
	Nerve root disorders	Brachial plexus avulsion	1	50	1	50	1	100	-	-	3
		Total #	2		1						
Total #		3									

Table 2. The incidence of traumatic spinal disorders by specie and sex

Conditions that required physiotherapy	Types	Subtypes	Dogs				Cats				Total #
			Males		Females		Males		Females		
			#	%	#	%	#	%	#	%	
Spinal disorders	Traumatic spinal disorders	Compression trauma in the hinged window	-	-	-	-	-	-	3	100	3
		Shooting trauma	-	-	2	100	-	-	-	-	2
		Thoracolumbar spine fracture	6	66.67	3	33.3	-	-	2	100	11
		Spinal subluxation	-	-	-	-	-	-	5	100	5

Table 3. The incidence of degenerative spinal disorders by specie and sex

Conditions that required physiotherapy	Types	Subtypes (1)	Subtypes (2)	Dogs				Cats				Total #
				Males		Females		Males		Females		
				#	%	#	%	#	%	#	%	
Spinal disorders	Degenerative spinal disorders	Deforming spondylosis (osteophytes)	-	4	40	6	60	1	100	-	-	11
		Disc herniations (sudden spinal cord compression)	Cervical	3	100	-	-	-	-	-	-	37
			Thoracolumbar	19	59.38	13	40.62	-	-	-	-	
			Lumbosacral	1	50	1	50	-	-	-	-	
Slow spinal cord compression	-	7	70	3	30	4	57.14	3	42.86	17		

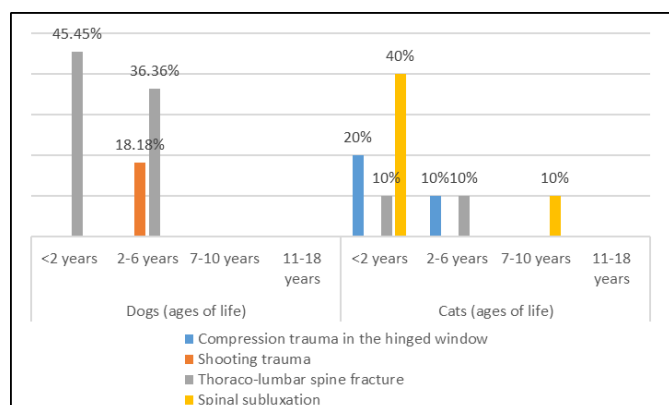


Fig. 3: The incidence of traumatic spinal disorders by specie and ages of life

thoraco-lumbar spine subluxations (5 cases; 23.81% of all traumatic spinal diseases), compression trauma in the hinged window (3 cases; 14.29% of all traumatic spinal diseases), and shooting trauma (2 cases; 9.52% of all traumatic spinal diseases). Cases of thoraco-lumbar spine fracture were found in both dogs and cats (9 dogs, 81.82% and 2 cats, 18.18%), the other types of traumatic spinal disorders being alternatively found in one specie of domestic carnivores: spinal subluxation and compression trauma in hinged glass - in cats, trauma in shooting - in dogs. The incidence of traumatic spinal disorders by specie and sex is shown in Table 2.

Degenerative spinal disorders encountered in the investigated cases were represented by: deforming spondylosis or osteophytes (11 cases; 16.92% of all cases of degenerative spinal diseases), disc herniation or sudden spinal cord compression (37 cases; 56.92% of all cases of spinal diseases degenerative), and slow spinal cord compression including compaction, pinching, narrowing of the intervertebral space, disc mineralization (17 cases; 26.15% of all cases of degenerative spinal diseases). Cases of disc herniation were located at the cervical level (3 cases; 8.11% of all cases of disc herniation), thoraco-lumbar (32 cases; 86.49% of all cases of disc herniation), and lumbo-sacral (2 cases; 5.41% in all cases of disc herniation). Regarding the distribution of degenerative diseases by species and sex, the 11 cases of deforming spondylosis were found in 10 dogs (90.91%), of which 4 males (40%) and 6 females (60%), and one cat (9.09%) of female sex. Cervical disc herniation was found in 3 male dogs, thoraco-lumbar in 32 dogs, of which 19 males (59.39%) and 13 females (40.62%), and lumbo-sacral in two dogs, one male (50%) and one female (50%). The 17 cases of slow spinal cord compression were found in 10 dogs (58.82%), of which 7 males (70%) and 3 females (30%), and 7 cats (41.18%), of which 4 males (57.14%) and 3 females (42.86%) (Table 3).

In order to establish the incidence of traumatic spinal disorders depending on the specie and age, 4 groups of age were formed for each of the investigated two species of domestic carnivores: < 2 years of age, 2-6 years of age, 7-10 years of age, 11-18 years of age. Of the total number of dogs with traumatic spinal disorders (11 individuals), 45.45% (5 individuals) were diagnosed with thoraco-lumbar spine fractures, aged < 2 years, while 36.36% (4 individuals) were aged between 2 and 6 years. 18.18% (2 individuals) were diagnosed with shooting trauma, being aged between 2 and 6 years. For cats, most of them were diagnosed with thoraco-lumbar spine subluxations

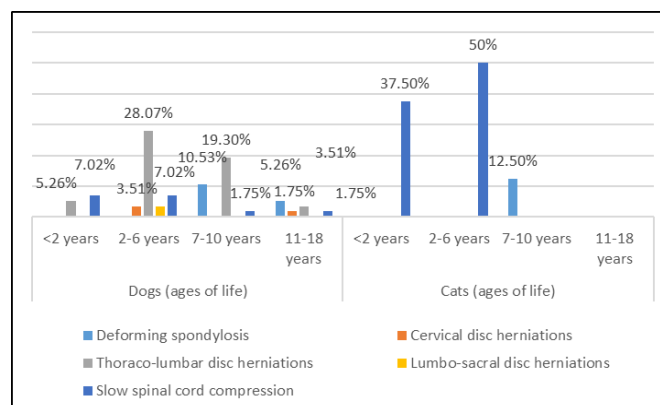


Fig. 4: The incidence of degenerative spinal disorders by specie and ages of life

(4 out of 10; 40%), being aged < 2 years, 20% (2 individuals) of the cases were represented by compression trauma in hinged glass, also aged < 2 years, each 10% of cases being subsequently found in thoraco-lumbar spine subluxations (7-10 years of age), thoraco-lumbar spine fractures (< 2 years and 2-6 years of age) and, compression trauma in hinged glass (2-6 years of age), respectively (Figure 3).

Considering degenerative spinal diseases, out of the total number of dogs thus diagnosed (57 individuals), most were in the group of thoraco-lumbar disc herniations 2-6 years of age (16 individuals; 28.07%), they being numerically followed by those with the same condition but in 7-10 years of age group (11 individuals; 19.3%); this condition was also diagnosed in 3 individuals (5.26%) in the age group < 2 years and another 2 cases (3.51%) in 11-18 years of age group. Deforming spondylosis was found in 6 individuals (10.53%) belonging to 7-10 years of age group, 3 individuals (5.26%) belonging to 11-18 years of age group, and 1 case (1.75%) belonging to < 2 years of age group. Cervical disc herniations were found in 2 individuals (3.51%) belonging to 2-6 years of age group and 1 individual (1.75%) belonging to 11-18 years of age group. Lumbo-sacral disc herniations were diagnosed in 2 dogs (3.51%) aged between 2 and 6 years. Spinal cord compressions were found in all 4 years of age groups, as follows: 4 cases (7.02%) in the groups < 2 years of age and between 2 and 6 years of age, respectively, and one case (1.75%) in the groups 7-10 years and 11-18 years, respectively. In cats, the cases of degenerative spinal disorders was much numerically limited compared to dogs. A high incidence was observed in the case of slow spinal cord compressions, 50% of the total degenerative cases (4 individuals) being found in 2-6 years of age group and 37.5% of the total cases (3 individuals) being found in < 2 years of age group. 12.5% of cases (1 individual) were of deforming spondylosis, in the category of cats aged 7-10 years (Figure 4).

Brachial plexus avulsion, the only disease diagnosed in the category of neurological disorders - diseases of the nerve roots, was found in 2 dogs, one < 2 years and the other one between 7 and 10 years, and a cat < 2 years of age.

Considering the distribution of traumatic spinal disorders depending on specie and breed, the following notes can be specified: in dogs, out of 12 total cases thus diagnosed, 2 were represented by trauma by shooting at half-breeds (16.67%), 9 by thoraco-lumbar fracture at half-breeds (75%), and one in Labrador (8.33%). Cases of traumatic spinal diseases in cats were found

only in the European breed, these being represented by compression trauma in hinged window (3 individuals out of 10; 30%), thoraco-lumbar spine fracture (2 individuals out of 10; 20%), and thoraco-lumbar spine subluxation (5 cases out of 10; 50%). Considering the distribution of degenerative spinal diseases, out of the total of 57 dogs thus diagnosed, 10 (17.54%) showed deforming spondylosis, of which 6 (10.53%) were half-breeds and each one (1.75%) of Rottweiler, German Shorthaired Pointer, Chow-Chow, and German Dog breeds, respectively. Cervical disc herniation was found in 4 dogs (7.02%), each one (1.75%) of half-breeds, Pekingese, Bichon, and Beagle, respectively. Thoraco-lumbar disc herniation was found in 32 dogs (56.14%), most of them being half-breeds (10; 17.54%), Bichon (9; 15.79%), Pekingese (5; 8.77%), and Tekel (4; 7.02%), and each one case (1.75%) in Poodle, German Shorthaired Pointer, Fox Terrier, and Westie. The lumbo-sacral disc herniation was found in only 2 half-breed dogs (3.51%). The 9 cases of slow spinal cord compression (15.79%) were found in half-breeds (4; 7.02%), Pekingese, Yorkshire, Bichon, Tekel, and Husky, one case for each aforementioned breed (1.75%). The 8 cases of degenerative spinal diseases in cats were found in the European breed, one case (12.5%) being of deforming spondylosis and the other 7 (87.5%), slow medullary compression. The 3 cases of brachial plexus avulsion were found each one in half-breed and Akita dogs, and a European cat.

## Discussions

The results of our research show a significant share of degenerative spinal disorders of the total neurological ones, these being followed by traumatic spinal disorders and those of nerve roots (brachial plexus avulsion). Each type of pathology was found with a differentiated incidence among dogs and cats, except for brachial plexus avulsion where, possibly due to the few cases, their distribution to the two investigated species was equal. For the rest of the diseases, the predominant damage of the dogs can be justified on the following arguments:

- a higher number of investigated dogs compared to cats;
- a preferential distribution either of congenital nature or by specie, such as deforming spondylosis which occurs with a higher frequency in dogs due to a lower degree of mobility of their spine compared to cats;
- a preferential distribution considering the nature of the event produced, such as shooting injuries that are more likely to be found in dogs than in cats. A similar example, but suitable for the cat, is the compression trauma in hinged glass which, by the nature of the event produced, is more likely to be found in cats than in dogs, especially if the windows are positioned at a considered normal height in building houses.

The preferential distribution of spinal fractures mostly in dogs, or spinal subluxations only in cats, we found to be related to the nature of the event produced, most likely a car accident or the application by man of direct blows with various blunt objects. This is confirmed, on the one hand, by the distribution by breeds, being affected half-breed dogs and cats of European breed, probably stray animals, but also by the age of life, being affected animals without urban experience of groups < 2 years and 2-6 years of age. The distribution by sex is purely accidental in the case of these diseases.

The degenerative diseases found in our study have a combined etiology between genetic predisposition factors (genes involved, breed, sex) and environmental ones (diet, various traumas in animal life). For example, in the etiology of deforming spondylitis or osteophytes in dogs is involved the gene TGF- $\beta$ 1 (Transforming Growth Factor Beta 1), also found in other species such as humans, chimpanzee, cow, mouse, rat, zebrafish, and frog. In dogs, the TGF- $\beta$ 1 gene is located in the structure of chromosome 1, it has on its structure 7 exons, and a number of 14410 bp (GenBank, 2020). Although in veterinary medicine studies of the association between TGF- $\beta$ 1 gene polymorphism and osteophyte occurrence are limited, in humans the polymorphism of the TGF- $\beta$ 1 gene in the signal region (T29→C) has been linked to the formation of spinal osteophytes (reviewed by Shen et al 2014; Wong et al 2016). Despite the sometimes contradictory data, it seems that the development of osteophytes and various joint diseases, such as fibrosis and not only, could be related to increased concentrations of TGF- $\beta$ 1 cytokines. Elevated concentrations of TGF- $\beta$ 1 are naturally found in bones and cartilage, stimulating the growth and proliferation of osteoblasts, the growth and differentiation of chondrocytes (Neumann and Lauenstein-Bosse, 2018).

Zukowski et al. (2012) reported the influence of age on the development of osteophytes as non-discriminatory, affecting men and women equally, but increasing body mass index due to aging and decreased sex hormones, on the one hand, and the development of osteophytes, on the other hand, as a factor that seems to affect women with predilection. In our study, a higher frequency of osteophytes in female dogs was observed, which seems to confirm the findings in human medicine. Interestingly, Xiao et al. (2010) established in humans an inverse correlation between the presence of osteophytes and osteoporosis in women, and a direct correlation between osteoporosis and age and body mass index.

Regarding disc herniations, genetic predisposition data show the involvement of multiple etiological factors in humans, of which the collagen IX genes or that of the Aggrecan protein can be briefly mentioned (Ala-Kokko, 2002). The collagen IX gene, also known as COL9, comprises the variants COL9A1, COL9A2, and COL9A3. They are responsible for encoding type IX collagen, with increased flexibility compared to other types of collagen, its lack characterizing various osteoarthritis in humans and animals (Feng et al 2016). Mutations in the COL9A2 and COL9A3 genes have been reported in some dog breeds as the genetic substrate for ocular skeletal dysplastic disorders, with an autosomal recessive transmission pattern (Goldstein et al 2010). The polymorphism of the ACAN gene may also be related to the functionality of the articular cartilage as soon as the encoded protein, Aggrecan core protein, is a proteoglycan major component of cartilaginous tissues that gives them the ability to withstand compression (Theodore et al 2019; UniProt KB-Q28342, 2020; Watanabe et al 1998).

In the case of slow spinal cord compressions, the etiological factors of a genetic nature associated with disc herniation might be added to those that underlie tumor developments with various locations on the length of the spine. The subject of spinal cord compressions due to tumor development is widely debated in human medicine, being with an etiopathogenesis of various genetic nature, depending on the type of spinal tumors:

ependymomas, arthrocytomas, haemangioblastomas, or meningiomas (Zadnik et al 2013).

Regarding the physiotherapy procedures applied to patients with neurological disorders included in the present study, these were part of special methods, such as electrostimulation and ultrasound therapy, associated as appropriate with manual methods, including passive movements (for contraction muscle being used external force) or active movements (printing of movements being made on the treadmill, with the animal supported in harnesses). Their application and the first satisfactory results obtaining were variable as the period of time and number of meetings; on average, satisfactory results were obtained after 40 sessions, in case of traumatic spinal diseases, after 20-30 sessions, in case of degenerative spinal diseases, and after 80 sessions, in case of brachial plexus avulsion, with cases of variable duration comparing to these average values depending on the severity of the pathology, the promptness of starting of physiotherapy procedures after the appearance of the first clinical signs of injury, or in the context of lack of consistency on the part of the owners in performing the daily established procedures.

## Conclusions

As a result of a total period of 21 months of clinical investigations, 89 dogs and cats were diagnosed with neurological disorders that required physiotherapy. Of these, 73.03% were with degenerative spinal disorders, 23.6% with traumatic spinal disorders, and 3.37% with nerve roots (brachial plexus avulsion). Dogs accounted for the majority of investigated patients (78.65%), this being often related to the increased frequency of diseases in this species compared to cats. On the other hand, some diagnosed diseases were suitable for the dog or cat due to the nature of the event produced; the genetic determinism and anatomophysiological particularities also determined such a preferential distribution.

The management of neurological diseases that required physiotherapy was a complex one through the diagnostic and therapeutic components. The hasty start of the physiotherapy sessions determined the complete fulfillment of the objectives of improving the muscle mass, regaining the balance and independence in walking, reducing the limping of the affected limbs. Physiotherapy procedures, although involving common working methods, were adapted according to the diagnosed pathology.

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