

## ABSTRACT

The doctoral thesis entitled "Researches on physiotherapy's applications in musculoskeletal system's disorders of the domestic carnivores" had the motivation the study of orthopedically and neurological disorders of pet carnivores, and the character of the originality of this work has been conferred by the studies performed on the effectiveness of the physiotherapy procedures in recovery of patients with disorders of musculoskeletal system.

The theme of the doctoral thesis is one descriptive document, aimed at addressing patients with locomotory disorders, showing clinical, diagnostic methods and treatment protocols for animals with mobility disabilities. The purpose of the work was to update, analyze and apply the data from literature, highlighting the importance of the physiotherapy protocols as regards recovery of the patients with mobility disabilities, with a view to the implementation of the protocol as well as the most appropriate treatment of each individual in part depending on the existing pathology.

The thesis is composed of two parts, the first part referring to the current state of knowledge, and the second part is personal research, comprising a total of 10 chapters. The first part represents the bibliographic study referring to the main diseases which may affect the musculoskeletal system, both from the orthopedical and neurological point of view; methods of clinical and paraclinical diagnosis, as well as the principal manual and special physiotherapy methods. And the second part, personal research referred to the results obtained during the four years of study.

Chapter I is entitled "The ethiopathogenesis of the locomotory system' disorders of the domestic carnivores" and describes the main locomotory disabilities from both orthopedic and neurological point of view, which can lead to walking defficiencies. Of the total pathologies which are likely to have repercussions on the musculoskeletal system, we could mention the congenital disorders (angular joint deformation, congenital craniomandibular osteopathy disorders), the inflammatory diseases (panosteitis, osteomyelitis), due to the nutritional disorders (rickets hypertrophic osteodistrophy, pulmonary hypertrophic osteodistrophy, and osteomalacia), damage due to the metabolic disorders (condrodystrophy, osteochondromatosis, bone trauma, tumors). In addition to the causes referred to above, we can also mention the traumatic lesions, materialized in most cases by fractures of the apendicular skeletal structures, but also through sprains and subluxations. We also mention the disorders of the muscle tissue, which could lead to walking disturbances: the fibrotic spasm of the infraspinous muscle, the fibrotic spasm of the suprascapular muscle, the gracilis muscle spasm, and also the tendons disorders, like: supraspinous tendon calcification, biceps muscle's tendon tenosynovitis, long digital extensor muscle's proximal tendon avulsion.

Neurological disorders can also impress changes of the musculoskeletal system, by affecting the transmission of the electrical impulses at the central level. In the framework of these pathologies, we can identify the damage to the spinal cord, nerve roots or periphery nerves.

Chapter II is called “Methods of diagnosis by clinical, orthopedic and neurologic examination in domestic carnivores”. Here are exposed the information presented in the literature related to the physical examination of the patient, from the original observations of the posture, up to the analysis of walking. Here are also detailed the diagnostic techniques using neurological and orthopedic examinations, in order to confirm or invalidate the existence of neurological or orthopedic pathologies. The methods presented in detail in this chapter sum up all the complementary exams needed to identify and then treat various pathologies of the musculoskeletal system. Firstly, both the orthopedic and neurological examinations must be done in a safe environment for both the examiner and the patient. The evaluation should be performed systematically in order to exclude the risk of not observing certain pathologies. Within this chapter, it is underlined the examiner's increased attention, correct handling techniques, and especially on the correct interpretation of the results obtained from the performed exams. It is also important to check in detail the patients' health status to identify whether there are subclinical pathologies affecting the treatment. Particular attention should be paid to cardiovascular, respiratory, gastrointestinal, hepatic, renal and endocrine systems.

The patients should be observed both staying and walking in order to observe the posture changes, possible lameness, as well as its degree, or the presence or absence of limb asymmetries. In all cases, the symmetry of the steps, proprioception, hypermetry, spine degree and the degree of flexion and extension of the joints should be evaluated.

The orthopedic evaluation can be done by using the congener member as a reference for comparing motion, limb circumference, and palpation sensitivity. The general neurological examination begins when the animal is presented to the clinic, the general appearance can be evaluated while the owner presents the anamnesis. Voluntary movements and posture may be significant indications of diseases in the central nervous system, spine, or other associated pathologies. Patients with paresis and paralysis are non-ambulatory, with remarkable changes in posture. Spinal reflexes and sensitivity should also be evaluated to highlight the presence or absence of reflex or sensory nerve functions of a particular body region. Precise location of injuries by orthopedic and neurological examinations is required to perform additional tests required at their projection area.

Chapter III, entitled "Paraclinic diagnosis of the main diseases of the locomotory system in domestic carnivores", presents the clinical, imaging and laboratory research methods necessarily to obtain a certain diagnosis. For each method there were exposed the particularities obtained by their systematic use, together with the significance of each on the differential diagnosis. Imaging techniques (radiography, fluoroscopy, myelography, ultrasonography, MRI and CT) are indispensable in the diagnostic protocol for musculoskeletal system disorders, highlighting the lesions present at this level. Particular attention should also be paid to complementary paraclinical examinations (haematological, serological, enzymatic or cytological tests), which may direct the examiner to the diagnosis of certainty. In this chapter are described the diagnostic imaging techniques, the modalities of use, but especially the choice of the most appropriate paraclinical examination depending on the anamnesis and the medical history of the patient.

The radiological examination is the most used diagnostic method in the locomotor system diseases investigations. The area of lesion projection is detected by corroborating the anamnestic and clinical data. Röntgen diagnosis methods are useful in detecting articular dislocations, fractures, neoplasia, but also in identifying congenital joint disorders. This technique is also used to evaluate the position of the stems and wires used in osteosynthesis surgery to assess the stage of fracture line strain and to identify the progress of various treatments used to ameliorate or treat bone or joint disorders. Performing the radiological examination with contrast substance is useful when establishing the presumptive diagnosis of obstruction or medullary compression caused by the presence of neoplasia, degenerative disc diseases or vertebral instability. This technique involves injecting the contrast substance into the intrathecal space of the spine. Contrast agents must meet certain characteristics such as sterility, the solution must be nonionic and iodinated.

Chapter IV, and the last chapter of the first part, entitled "Physiotherapeutic methods used in locomotory system's disorders in domestic carnivores", refers to the current methods and techniques used in the rehabilitation of animals with locomotor diseases. There are described both manual physiotherapy methods related to kinesitherapy and massage, as well as special physiotherapy methods, among which electrostimulation, laser therapy and ultrasound. Classical physiotherapeutic methods should be tailored to each patient, diagnosis, and outcome. Both manual and special physiotherapy methods have an important place in the therapeutic protocol of patients diagnosed with neuro-muscular or orthopedic disorders. The correct combination of these physiotherapeutic methods is the key to the treatment's success.

Manual physiotherapy methods, represented by a range of active and passive movements, stretching exercises, aquatic therapy, application of cryotherapy and heat, help increase joint flexibility, improve mobility, maintain muscle tone, tendons and ligaments. The rate of joint movement can be altered by affecting the integrity and flexibility of the periarticular structures. Passive movements performed postoperatory reduce pain and improve patient recovery rate, prevent joint and soft tissue contraction, maintain mobility between soft tissues and increase the blood flow in the affected area. The range of active movements can be achieved when the patient can control the muscular activity to a certain extent, the role of the therapist being just to guide the movements of the joints. One type of effective exercise that is part of the assisted active moves is swimming. It helps strengthen the muscles, with the water helping the patient to partially support the body weight. There are also contraindications to the use of the aquatic therapy, referring to the individual characteristics of the patients (water phobia may be present in some dogs, the cardiovascular pathologies presented in some individuals), in situations where postoperator wounds or decubitus wounds are not completely closed, so there is a risk of associating secondary infections. Stretching techniques are commonly used together with the range of active movements. These help to improve the joints flexibility, but also the extensibility of the adjacent tissues.

Thermal methods are often used in physiotherapeutic protocols due to beneficial effects on affected superficial tissues. Cryotherapy is primarily used for primary

physiological effect including vasoconstriction, reduction of vascular permeability, reduction of cellular metabolism, minimization of inflammatory side effects following demanding exercises, reduction of post-traumatic edema and reduction of muscle spasms. Applying cryotherapy can be done with ice packs, cold compresses, cold dipping, and ice massage. Superficial heat application can be achieved with commercially available packages. Thermal therapy is contraindicated in the early stages of acute inflammatory processes because it exacerbates the body's reaction, in tumoral processes, or in the case of skin or subcutaneous haemorrhage.

Special physiotherapy methods, such as electrotherapy, ultrasound therapy and laser therapy, are commonly used in physiotherapeutic protocols. Electrotherapy is a method of excitement of the superficial neuromuscular tissue that helps to improve the rate of movement, muscle tone, enhancement of functions and control of pain, but also to reduce edema and muscle spasms. Ultrasound therapy can be used to rehabilitate patients with localized diseases in the musculoskeletal system, reducing pain and muscle spasms. Laser therapy can be used in a wide variety of conditions, helping to improve nerve conductivity, angiogenesis stimulation and blood flow alteration.

The second part of this paper entitled "Personal Research" is represented by individual researches on the physiotherapy's role in the treatment of orthopedic and neurological diseases, consisting of five chapters, two of which are individual studies on the efficacy of applying physiotherapy techniques in treating or ameliorating neurological disorders in domestic carnivores.

Chapter V is entitled "Purpose and Objectives of Research". Within this chapter there are described in detail the ways of evaluating the patients from the physiotherapeutic point of view, the methods of adaptation of the treatment corroborating the clinical signs, the results of clinical and paraclinical examinations, as well as the main effects expected from performing the physiotherapy techniques such as the reduction pain, slowing down atrophic muscular processes, diminishing edema, or improving locomotor function.

Chapter VI is titled "Materials and Methods of Study on Locomotor Disorders in Companion Carnivoras". In this chapter, there are described the standard diagnostic protocols for orthopedic or neurological disorders, patient evaluation being performed systematically, starting with clinical examination and continuing with neurological, orthopedic and radiological native or contrast examinations, and in the case of patients who presented a complex symptomatology, common to several pathologies, we had recourse to the ultrasound examination and / or additional blood tests. The importance of applying physiotherapeutic techniques in the treatment of locomotory disorders in companion carnivoras as an adjuvant in the recovery of locomotor functions can be deduced from the physiology of neuromuscular tissue, which is an excitable tissue that functions on the basis of electrical impulses produced by variable distribution of ions. Manual physiotherapy methods are used to actively improve muscle mass and strength, restore the balance, and facilitate the regaining of walking independence. In the case of patients with paraplegia or tetraplegia, particular importance in the therapeutic protocol presented the exercises to maintain the standing position. Several body weight support devices fitted with harnesses and straps adapted to individual patients' needs, as well as

two- or four-wheeled carts, used according to individual neuromuscular capacity, were used in these exercises. The role of these exercises is to regain the muscles strength, but they also have a role in reducing the pressure exerted on bone prominences, thus reducing the formation of decubital wounds. Ownoe training and weight center exercises also play an important role in regaining patient locomotor independence. These exercises were performed with special devices that provided support surfaces with different textures, thus stimulating both superficial nerves and extremity muscles. In weight center exercises, rewards have been used to stimulate the attention, but also to encourage patients to perform specific exercises. Also, exercise balls and rolls can be used in veterinary physiotherapy to improve balance, coordination, but also to regain muscle strength. When the patients regained total or partial independence in walking, the most important exercises are walking in leash, sloping or rafting, climbing stairs and running on the treadmill. These exercises help strengthening the muscles, and the distribution of body weight is altered when changing the travel angle. Running on the treadmill is also useful in shaping the walking, but also in encouraging the animal to support its weight on the affected limb. Walking through high grass or snow is another exercise that helps improve the coordination of movements, requiring additional effort, thus strengthening limb muscles due to extensive movements to walk on these types of field.

An indispensable feature of any physiotherapy protocol is adaptability, so programs and exercises should be modified not only by individual patients but also by advances in previous physiotherapy sessions. The adaptation of physiotherapy protocols is achieved by introducing or removing certain exercises, by increasing the exercise time, or by increasing or decreasing the intensity of the exercises.

Special physiotherapy is the use of specialized devices that stimulate, using physical factors, the increase of the muscle mass, the increase of the vascular permeability, and induce the analgesic and anti-inflammatory effect. Thus, during the physiotherapy sessions, the manual methods presented above were supplemented by special techniques such as ultrasound, electrostimulation, heat application or laser therapy. By combining these techniques, individual therapeutic protocols have been developed, both by pathology and by individual characteristics of the patients.

Also, in this chapter there are described the number of sessions, the basic scheme of the therapeutic protocol choosed according to the pathology, but also the time used in each treatment session, also depending on the type of affection. Bone trauma had the most significant proportion in all patients presenting in the clinic with orthopedic disorders, the number of physiotherapy sessions ranging from 20 to 40, depending on the start of postoperative treatment. In the case of neurological disorders, the highest share was represented by degenerative diseases of the spine, the hernia being the pathology with most patients. Thus, there were 35 cases with a discal protrusion, the highest incidence being recorded in the thoraco-lumbar region, ie 23 cases. The number of physiotherapy sessions ranged between 20 and 30 sessions, and the Olby score following the treatment ranged between 12 and 14 points.

Chapter VII, entitled "Results and Discussions", describes in detail the results obtained from the examination of pet carnivores presented in the Medical Clinic of the

Faculty of Veterinary Medicine in Iasi with locomotor system disorders. Thus, out of the total of 183 cases requiring physiotherapy, 117 patients presented neurological conditions, and in the remaining 66 patients the conditions were orthopedic. The patients were divided according to their species, race, sex and age, thus, 129 patients belonging to the canine species and 54 of the feline species were registered. Depending on age, the highest share was recorded, in canine patients in the age group between 2 months to 3 years old, represented by 50 cases, and in feline patients, the best represented group was that of patients between 3 and 7 years old, totaling 23 cases. Regarding the prevalence of locomotor diseases according to race, both in dogs and cats, the crossbreeds occupy the main place because of their large number in the area where the research was carried out.

In the case of orthopedic disorders, the most significant site is occupied by femoral fractures, amounting 20 cases, and in the case of neurological diseases, spinal cord diseases were best represented, amounting 100 cases.

Clinical examination of patients presenting with the locomotor disease was performed using general screening methods, using the great semiological methods, the data obtained from this examination led to the realization of the individual observation sheet and the identification of the patients. Inspection plays an important role in the clinical examination because we can identify the affected area, obvious clinical signs such as lameness, or paresis or paralysis. Also within the inspection we can appreciate the moment of occurrence of the symptomatology, by observing the possible bedsores or grinding injuries.

The orthopedic examination is also an important part of the diagnosis of certainty, by means of this degree of limb symmetry, the presence or absence of muscle atrophy, the presence or absence of bone cramping, the presence of abnormal movements at the joints, or the modification of the joints angles. Thus, following the orthopedic examination, most of the cases recorded in our clinic for patients with orthopedic diseases were diagnosed with hip and femoral pathologies.

Performing the neurological examination is necessary in all cases of patients with locomotory diseases, to precisely locate the injuries. In neurological locomotory diseases, degenerative diseases occupied the first place, these being represented by a total of 55 cases, of which 35 patients with discal protrusion and 20 with deforming spondylitis. The following category of disorders represented by 38 cases was the group of patients with traumatic stress disorders in the spine. Other types of conditions were present in the study, with fewer representatives, such as spinal cord diseases diagnosed in 3 cases, of which 2 cases with fibrocartilage embolism and one case of medullary infarction. Spinal abnormalities had 4 representatives, and nerve root diseases, represented by polyradiculoneuritis, were diagnosed in 12 dogs. Of the 12 cases with polyradiculoneuritis, the majority were females aged between 6 to 8 years old. Another category of diseases present in this study was the peripheral nerve disease characterized by brachial plexus avulsion, a pathology characterized by the occurrence of monoplegia in one of the thoracic limbs.

The radiological examination was performed on all patients undergoing the study and aimed to confirm or invalidate the presumptive diagnosis. Following clinical,

orthopedic and neurological examinations, patients were directed to the Department of X-ray Diagnosis and Veterinary Imaging of the Faculty of Veterinary Medicine in Iasi to perform native radiological examinations or, by case, radiological examinations with contrast substance.

Radiological imaging has been instrumental in establishing the diagnosis of certainty in all pathologies associated with the locomotor system, such as congenital disorders of metabolic and inflammatory nature, which have revealed the following pathologies: craniomandibular osteopathy, commonly found around the age of 3-8 months in dog breeds like Boston Terrier, West Highland White Terrier and occasionally also in other dog breeds; panosteitis, affects large breed dogs aged between 5 and 18 months, the radiological aspect of which is the appearance of "cigarette smoke" seen in the diaphysis of long bones; hypertrophic osteodystrophy, pathology affecting dogs aged 2 to 8 months old, characterized by the formation of growth plaques in the epiphysis, resulting in an inflammatory process at the articular level; rickets, caused by metabolic deficiencies of calcium and magnesium, as well as deficiencies in vitamin D and phosphorus, affect young people regardless of race.

Bone traumas are described as shape and contour changes, which can be easily observed by performing the native radiological exam. Within this group of disorders, we can enclose the fractures, vicious calcification and neoplastic processes at the bone level. Fractures are described as lesions of bone discontinuity, and their etiology is often traumatic. These can be found in all bones, the most common ones being those of the long bones. Fractures can occur in all age groups, with younger and geriatric animals being more susceptible.

Neoplastic processes of bone tissue can be found in both dogs and cats, their malignancy being determined by bone biopsy. These tumor portions can be observed radiologically, producing changes in shape and contour in the bone surface.

In Chapter VIII, entitled "Development of Spinal Gait in Patients Without Deep Sensitivity", there are described the physiological and metabolic processes produced in the peripheral nerves of animals with central nervous system injuries. These animals are devoid of profound pain sensitivity, the predominant clinical sign being paraplegia. In this chapter, the study of 29 patients with spine disorders with no profound painful sensitivity was detailed. Throughout the study, with the help of physiotherapy sessions, most patients managed to develop a type of reflex walk, called spinal walking. The physiotherapeutic protocol was composed of both manual techniques and special physiotherapy techniques. Running exercises were the most used in physiotherapy sessions. The results of the study concluded that 17 dogs, out of a total of 29 patients, managed to form a spinal autonomous course, requiring a number of sessions between 40 and 120, depending on the individual, the location of the lesion, but especially based on the number of days elapsed since the lesion occurred. The best results were recorded for patients with normal body weight, especially small races. Another defining factor in the success of the spinal gait formation is the age of the patient, the study revealing positive results for the youth. Regarding the time elapsed from the occurrence of the lesions, until the beginning of the physiotherapy sessions, faster improvements were observed in the patients who started treatment earlier,

requiring a smaller number of sessions to succeed in developing the autonomous spinal walking.

All patients included in this study were examined clinically, orthopedic and neurologic, and in some cases paraclinical examinations were also required. The physiotherapeutic protocol was established individually, being adapted to the needs of each individual patient. The physiotherapy sessions took place daily, with the average duration of each session being one hour. The program was adapted during the sessions according to the individual progresses, but also according to the prognosis. The variation in the number of meetings depended on the patients' evolution and the owners' wish to continue or not the treatment.

Based on this study, we can conclude that chances of recovering locomotor autonomy decrease drastically if physiotherapy sessions are not started within the first two weeks of injury. Also, the study shows that patients who have suffered irreversible spine injuries can develop a spinal gait reflex, succeeding in regaining their independence in locomotion if the treatment is started early.

Chapter IX is entitled "Evaluation of the efficacy of physiotherapy on urinary incontinence" and describes in detail the effects of applying manual and special physiotherapy techniques to patients who have clinical signs of urinary incontinence. This condition is the consequence of several neurological pathologies, so that the application of electrostimulation to the pelvic region muscles performs two elementary functions: strengthening the muscles of the bladder sphincters and inhibiting the bladder contractility. The advantage of applying physiotherapy techniques is the lack of adverse effects common to specific drug treatments.

20 patients, including 15 dogs and 5 cats, were evaluated in this study. The effects of physiotherapy on urinary incontinence were assessed at the Medical Clinic of the Faculty of Veterinary Medicine in Iasi, all the animals under study presenting clinical signs of various neurological disorders, especially expressed in urinary incontinence.

The number of electrostimulation sessions varied between 7 and 50. The therapeutic protocol was individually set according to the pathology, age and timing of clinical signs.

Micturition is a voluntary reflex act, controlled by cortical inhibition. Urinary incontinence is a complex syndrome characterized by involuntary micturition, performed effortlessly, without the adoption of a characteristic position. This syndrome can be found in many forms, such as stress, superfluency, and neurological or reflex.

The application of electrostimulation aims at producing muscle contractions, thus strengthening regional muscular tissues. In animals with urinary incontinence, electrostimulation in the pelvic region causes the contraction of the muscles located near the bladder.

The clinical signs observed in patients undergoing study varied according to the primary condition, the common clinical sign being urinary disorders. The diagnosis of certainty was established after the imaging exams, represented by radiography and ultrasonography. The therapeutic protocol consisted of combining manual physiotherapy techniques (massage, the use of balls and special platforms) with special techniques (electrotherapy). Physiotherapy sessions were adapted during treatment, starting with a



minimum of 5 minutes of electrotherapy, up to a maximum of 20 minutes, once in two days.

Major improvements have been observed following electrostimulation to alleviate symptoms of urinary incontinence in pet carnivores. Thus, of the total of 20 patients enrolled in the study, 13 had a full recovery following the treatment, 2 patients had moderate improvements, and 5 of them had no improvement.

The number of sessions varied according to the individual patient's evolution, one patient being fully recovered after seven sessions, and another patient had no improvement neither after 50 sessions. The average number of physiotherapy sessions was 20. The success of treatment could not be correlated with the intrinsic factors of individuals such as race, age or gender.

Corroborating the data from this study, we can conclude that electrostimulation can successfully replace the classic drug therapy or surgical approach in urinary incontinence.

Chapter X is entitled "General Conclusions" and sums up the results obtained during the four years of doctoral research, with a study base of 183 pet carnivores. Thus, of the total number of patients present at the clinic over the four years, most (117) showed signs of neurological diseases. Also, regarding the species distribution, we were able to highlight the predominance of canine patients (129).

The thesis ends with the presentation of the list of 218 references titles in the foreign and Romanian literature, used as scientific support for this work, and the list of published scientific papers from the thesis.