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ANATOMICAL AND CLINICAL ASPECTS IN CANINE HIP DYSPLASIA

431.02 - ANIMAL MORPHOLOGY, MORPHOPATHOLOGY AND ONCOLOGY

Summary of the Doctoral Thesis in Veterinary Medical Sciences

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CONCEPTUAL FRAMEWORK OF THE RESEARCH

Relevance of the Topic. The opportunity for a thorough anatomic-clinical study, aimed at determining the morphometric indices of growth and stabilization of the elements of the supporting and locomotor apparatus in the coxofemoral region of dogs, the sources of vascularization and innervation, and the formation and distribution of the vascular bed and nerve network in regional muscles and the articular capsule of the coxofemoral joint, reflects the interests of veterinary practitioners, pedigree dog breeders, and specialists in mammalian biology.

Determining the causes and particularities of congenital, traumatic, or orthopedic pathology leading to hip joint dysplasia remains a current and debatable issue among veterinarians.

The multitude of specialized bibliographic sources [1, 2, 6, 7, 10, 11, 12, 15, 16], provides researchers with fragmentary information about the structure, correlations, and biomechanics of the canine hip joint.

In the last decade, publications by several authors have elucidated the results of anatomical dissections on cadavers to understand the biomechanics of the hip joint [4, 8, 9, 10, 14, 21] However, in the live animal, only imaging methods can provide accurate morpho-functional data regarding the pathological severity, complexity, and duration [3, 13]. Furthermore, imaging methods can ensure patient monitoring in evolutionary disorders or postoperative investigation.

Specialized literature mentions that the configuration and functionality of the hip joint in dogs can be affected from the earliest ages, even from the intrauterine period, in cases of congenital hip dislocation [5, 10, 16], which is a condition with severe, irreparable evolution, having a significant impact on the quality of life of both the animal and its owners.

Description of the situation and identification of the problem in the research field. Anatomic-clinical and variational aspects of the coxofemoral joint in dogs, sources of vascularization and innervation, the architecture of the vascular bed and nerve network have been studied through methods of classical anatomical dissection, vessel injections, and analysis of vascular pathways by preparing specimens obtained through corrosive methods of adjacent tissues [3, 17, 20].

This work is an attempt to complement studies conducted so far and to extend scientific investigations that will offer morphologists, biologists, veterinarians, and performance dog breeders the means for early detection of hip dysplasia in dogs.

The research hypothesis focuses on studying the morphometric indices of the elements of the supporting and locomotor apparatus in the coxofemoral region in dogs, the sources of vascularization and innervation, the formation and distribution of the arterial vascular bed and nerve network in regional muscles and the coxofemoral articular capsule; correct positioning of dogs to obtain radiographic images for diagnosing coxofemoral dysplasia in dogs.

The purpose of the work. To study the anatomic-clinical aspects of the formations of the supporting and locomotor apparatus in the coxofemoral region, determine the particularities of vascularization and innervation, the formation and distribution of the vascular bed and nerve network in regional muscles and the coxofemoral articular capsule in dogs, both in normal conditions and in suspected cases of hip dysplasia syndrome.

In order to achieve the proposed goal, **the following objectives were set:**

1. Establishing the morphometric indices of growth and stabilization of the elements of the supporting and locomotor apparatus in dogs.

2. Studying the anatomic-topographic variations of the origin of arteries, formation, and distribution of the vascular bed through macroscopic methods.

3. Highlighting the origin, pathway, endings, and interrelations of the para-articular nerve network and fibers.

4. Specifying the correct positioning method of dogs for obtaining roentgenographic images, in order to determine the values of the Norberg angle, a necessary criterion in diagnosing coxofemoral dysplasia in dogs.

Scientific research methodology. The investigation was carried out in the Laboratory of Morphology and Morphopathology of the SASP Department within the Technical University of Moldova (TUM), in collaboration with veterinary clinics in Chișinău municipality and the city of Brăila, Romania, in accordance with the normative requirements of ANACEC and respecting international legislation regarding animal protection and other national legal provisions.

As research material, dog cadavers obtained from veterinary clinics and organizations owning dog breeding facilities were used. Depending on the set objectives, anatomical dissection was performed on fresh or formalin-fixed material.

For dissections, purebred and mixed-breed animals of different sexes and ages were used, established based on internal registry records and examination sheets from veterinary clinics, ensuring beforehand that they did not present biological hazards (zoonoses such as rabies, leptospirosis, listeriosis, etc.).

Morphometric research was conducted on muscle groups acting on the coxofemoral joint in dogs.

The sources of vascularization and the architecture of the vascular bed were highlighted using the macromicroscopic method of fine anatomical dissection according to Vorobiev V. P. (Vorobiev, V.P., 1958). Blood vessels were injected with polymer, then subjected to corrosion, photographed, and schematic drawings were made. Additionally, vessels were injected with contrast substances to obtain roentgen images.

Radiological images of the pelvic region were examined for diagnosing hip dysplasia and calculating the values of the Norberg angle.

Morphometric evaluations of the muscle groups acting on the hip joint were performed according to the „Guide for Measuring Macro- and Microscopic Objects” [18]. Statistical processing was carried out using the reductive selection method – Student's t –Test, a statistical method used in hypothesis testing for comparing indices between groups.

Innovation and originality in research. In premiere, a morphometric study of the musculo-ligamentous complex of the coxo-femoral joint in the dog was performed, establishing the sources of innervation and distribution of nerves to determine their contribution to the innervation of the musculature adjacent to the coxo-femoral joint.

For the first time in revealing the sources of para- and intra-organic vascularization, methods of fine anatomical dissection according to Vorobiov, V.P. (1958) were used, confirmed by injecting blood vessels with solidifiable masses, subsequently subjected to chorion, and contrast substances, to obtain roentgen images. Thanks to the methods used, three variants of branching of the arterial vessels irrigating the anatomical formations of the hip region in the dog were established.

A macro- and microscopic anatomic-topographic study of the anatomical formations of the gluteal, coxofemoral, and femoral regions (bones, joints, muscles, blood vessels, nerves) was conducted. Early diagnosis of hip dysplasia was elucidated through morphometric, comparative, and roentgenological research with the establishment of Norberg angle values.

Important scientific problem solved in this field. Through specific research methods, new results were obtained regarding the examination of dogs suspected of suffering from hip dysplasia; using injection methods, tissue corrosion, and vessel radiography, the vascularisation sources and architecture of the vascular bed in the coxofemoral region were established, as well as the presence of different distribution variations of blood vessels. Both the topography of innervation sources and the distribution of nerve trunks were established, with morphological and variational interpretation of the sources of innervation and the mode of nerve distribution in regional anatomical formations. The aspects and modalities of the biodynamics of the musculature acting on the coxofemoral joint were described. Through radiological research, the values of the Norberg angle were calculated for different breeds of dogs.

Practical applicative value of the research. The results obtained allow the elucidation of the development and stabilisation characteristics of the bone and cartilaginous components of the coxofemoral joint in the growth of purebred dogs. Radiographic examination of the hip area is recommended for early detection of hip dysplasia. Knowledge of the arterial vascularisation sources, innervation sources, and nerve trunk distribution provides guidance in performing surgical interventions in this region. It is recommended to use for breeding only purebred dogs free from coxofemoral joint dysplasia, in accordance with the protocol of the Fédération Cynologique Internationale regarding the classification of dysplasia grades (A, B, C, D, E). Dogs that present dysplasia of grades C, D, and E should not be used as paternal lines.

Main scientific results submitted for defense.

1. Comparative evaluation of the conformation and biomechanics of regional muscles acting on the hip joint.
2. Morphological characterization of extra-organ vascularization sources and intra-organ architecture of the vascular bed in anatomical formations adjacent to the hip joint.
3. Identification of distribution variants of arteries and their branches based on criteria: origin, pathway, number, branching pattern, and determination of the variation frequency of each individual artery.
4. Characterization of extra-organ sources of innervation and elements of the peri- and intra-organ nerve network in regional coxofemoral anatomical formations.
5. Analysis of radiological images of articular bone formations in the pelvic region for the diagnosis of hip dysplasia, based on calculating the values of the Norberg angle.

Implementation of scientific results. The results of the work have been implemented in the teaching process at the Faculty of Veterinary Medicine of TUM, the University Veterinary Medical Centre, kennels of the Cynological Directorate of the Ministry of Internal Affairs, and veterinary clinics – Ciavdar Group LLC.

Approval of scientific results. The research results were presented and discussed at the following scientific forums: International Scientific Conference "Current Issues of Morphology", dedicated to the 75th anniversary of the founding of Nicolae Testemițanu State University of Medicine and Pharmacy , Chișinău (2020); The 74th Scientific Conference of Students, Master's, and Doctoral Students, CE UASM, Chișinău (2021); International Scientific and Practical Conference "Biosafety, Protection, and Animal Welfare," Kyiv, Ukraine (2021); The 10th International Conference of Zoologists "Rational Use and

Protection of the Animal World in the Context of Climate Change" dedicated to the 75th anniversary of the creation of the first research subdivisions and the 60th anniversary of the founding of the Institute of Zoology. Chișinău, Republic of Moldova (2021); The 2nd International Scientific-Practical Conference "Actual Aspects of Science and Education Development", Odessa, Ukraine (2022); The 4th International Scientific Conference "Current Epidemical Challenges in One Health Approach", Ternopil, Ukraine (2023); The 13th CASEE Conference "Smart Life Sciences and Technology for Sustainable Development" at the Technical University of Moldova, Chișinău (2023); International Scientific and Practical Conference "Biosafety, Protection, and Animal Welfare", Kyiv, Ukraine (2023); XV International Scientific Conference "Biomorphology Today" dedicated to the 100th anniversary of the founding of the Kyiv Scientific School of Comparative Morphologists and the 35th anniversary of the establishment of the Museum of Anatomy. Kiev, Ukraine, 2024.

Publications on the thesis topic. The study results were published in 11 scientific papers, including: one article in journals from the National Register of *Profile Journals category B,* article in a foreign profile journal "Veterinary Biotechnology", *category B*, Ukraine, six articles in international collections, two international thesis communications, and one national thesis communication.

Volume and structure of the thesis. The structure of the thesis includes 172 pages and summaries, lists of tables, figures, annexes, and abbreviations, introduction, 4 chapters, general conclusions and recommendations, bibliography which includes 237 references, declaration of responsibility, and the author's CV. The thesis is illustrated with 21 tables, 36 figures, and 8 annexes, 125 pages of basic text. The investigation results are presented in 11 scientific works.

Keywords: dogs, hip joint (coxofemoral joint), hip dysplasia, vascular bed, nerve network, roentgenoscopy, tissue corrosion.

CONTENT OF THE THESIS

Inthe **Introduction,** the actuality and importance of the investigated topic are briefly argued and reflected upon. Eloquent data are presented on the evolution of morphometric and anatomical-topographic research, which focus on the morphometric indices of the elements of the supporting and locomotor apparatus in the coxofemoral region of the dog, the sources of vascularisation and innervation, the formation and distribution of the vascular bed and nerve network in regional muscles and the coxofemoral joint capsule. The importance of correct positioning of dogs for obtaining radiographic images for the diagnosis of hip dysplasia by estimating the values of the Norberg angle is emphasized. The purpose and objectives of the work, the scientific novelty of the research, the hypothesis and methodology, the theoretical significance, practical applicability of the thesis, as well as the implementation and validation of the obtained results, are also presented here.

1. ANALYSIS OF RESEARCH ON ANATOMICAL AND TOPOGRAPHICAL ASPECTS OF THE COXOFEMORAL REGION IN NORMAL AND DYSPLASIA CASES

That chapter provides a comprehensive synthesis of national and international scientific publications on the anatomical and topographical features of the hip joint, the characteristics of morphometric indices, the structure and biomechanics of the muscles acting on the coxofemoral joint, the vascularization of regional musculature at extra-organic, peri-organic, and intra-organic levels, as well as the sources of innervation and the nerve network of periarticular anatomical formations.

It should be noted that data from specialized literature were also analyzed in this chapter to carry out a statistical analysis of all stages of scientific research.

Based on the synthesis of scientific works in the reference domain, a variety of individual anatomic-topographic variability was established regarding morphometric indices, sources of vascularization and innervation, and their role in ensuring the normal functionality of the hip joint. Publications concerning canine hip dysplasia—which is reflected by a malformation of the hip joint, the incidence of this disease, and the factors that cause it—were analyzed and systematized. The role of radiological examinations in the pelvic region for diagnosing hip dysplasia, by observing the values of the Norberg angle as an indicator of predisposition to dysplasia, was emphasized.

2. MATERIALS AND METHODS OF RESEARCH.

2.1. Subject of study

Scientific research on the anatomical structures of the pelvic limb, particularly the hip joint region, emphasizing the distribution principles of the nervous system, the vascular architecture of the coxofemoral area, as well as the morphological and morphofunctional characteristics in dogs, was conducted in the Laboratory of Morphology and Morphopathology within the Department of Food Safety and Public Health, Faculty of Veterinary Medicine, at the University Veterinary Medical Centre of the Technical University of Moldova, from 2018 to 2024, under the approval of the Research Programme, Order No. 713 dated 04.11.2019.

As research material, 57 x-ray films and 46 fresh dog cadavers of various breeds, ages, and sexes were used, either recently deceased from physiological reasons (traffic accident, senility), clinical conditions (canine parvovirus, electrocution, life-incompatible parasitoses, etc.), or euthanized at the owner's request, which would not affect the anatomic-topographic and morphological results of the coxofemoral region. The dog cadavers were immediately collected from different veterinary organizations and clinics within the municipality of Chișinău and subjected to various research techniques and methods (table 2.1).

Table 2.1. Characteristics of the material and research methods

Studied Material / Research Methods	Total	Male	Female	Body side		Age, years				
				Right	Left	0-0.6	0.7-1	2-5	6-8	9-11
Nerve preparation (Vorobiov method)	**8**	3	5	8	8	0	2	3	2	1
Injection methods	**14**	7	7	14	14	1	3	5	3	2
Corrosive method	**9**	5	4	9	9	1	2	4	1	1
Morphometric measurements/ gravimetry	**10**	5	5	10	10	1	1	6	1	1
Erlich-Dogel staining method	**5**	3	2	5	5	1	1	2	1	0
Total	**46**	**23**	**23**	**46**	**46**	**4**	**9**	**20**	**8**	**5**
Imaging methods	57	39	18	57	57	-	-	-	-	-
Total	103	-	-	103	103	-	-	-	-	-

2.2. Scientific research methods

The application of the morphometric method in research enabled us to obtain and analyze statistical data, through which certain criteria and trends in the development and stabilization of the static and biodynamic structures of the dog's hip joint were established.

Research methods involving vessel examination included the injection of a polymer mass homogenized with fluorescent dye, which was later subjected to corrosion. Throughout the entire dissection process, photographs, drawings, and graphic schematics of the vascular bed and nerve branching in the region were created, paying particular attention to the origin and variations of the arteries, with data being recorded with the highest accuracy.

The highlighting of the components of the autonomic nervous system at the level of the joint capsule was performed using methylene blue staining according to the Erlich-Dogel method.

Great importance was given to the radiographic procedure for evaluating hip dysplasia according to FCI standards. It was necessary for the radiographic images to be interpreted and scored by veterinary doctors specialized in this field, to establish the diagnosis and assess the degree of hip joint dysplasia in dogs.

3. ANATOMIC – TOPOGRAPHIC PARTICULARITIES OF THE COMPONENTS OF THE COXOFEMORAL REGION

This chapter contains data reflecting the particularities of the morphometric indices of growth and stabilization of the elements of the supporting and locomotor apparatus; the sources of vascularization and the architecture of the vascular bed; the sources of innervation and nerve distribution in the coxofemoral region. Through the conducted research, it was possible to monitor the processes of development, growth, and functionality of the coxofemoral articular and periarticular anatomical formations.

3.1. Aspects concerning the structural organization and biodynamics of the coxofemoral joint

Anatomical-clinical methods have significant value for assessing age-related changes, as well as structural components and dysfunctions.

The coxofemoral joint is one of the most robust joints in the dog's body, extremely sensitive to load in the case of axial anomalies. Its stability and mobility are due to the combination of a very resistant joint capsule, its ligaments, and the muscle mass that surrounds it.

The muscle masses located caudal to the thigh region are formed by three primary muscles: *M. biceps femoris* – located laterally; *M. semitendinosus* – caudal; and *M. semimembranosus* – medial (figure 3.1.1).

The four lateral muscles of this group – *M. tensor fasciae latae, M. gluteus superficialis, M. gluteus medius*, and *M. gluteus profundus* – are important due to their proximity to the hip. They are situated caudal to the hip and extend from the inner and outer surfaces of the ischium to the femur. All function to rotate the limb laterally. This action opposes the medial rotation by other gluteal muscles, allowing the thigh to move in the sagittal plane at the hip.

The deep muscles of the pelvis, by their location, are completely camouflaged by the formations adjacent to the coxofemoral joint.

The cranial muscles of the thigh are located at the internal angle of the coxofemoral bones and the external angle of the knee, being placed in a deep plane.

The medial muscles of the thigh are highly developed and overlap in two distinct layers: deep and superficial. The surface layer consists of *M. gracillis, M. sartorius,* while the deep layer includes *M. pectineus and Mm. adductor (*figure 3.1.2).

Figure 3.1.1. Superficial muscles of the left pelvic limb, caudolateral view: *1 – M. semimembranosus, 2 – M. semitendinosus, 3 – M. biceps femoris, 4 – M. gluteus superficialis, 5 – M. gluteus medius.* Piece by A. Dumitriu.

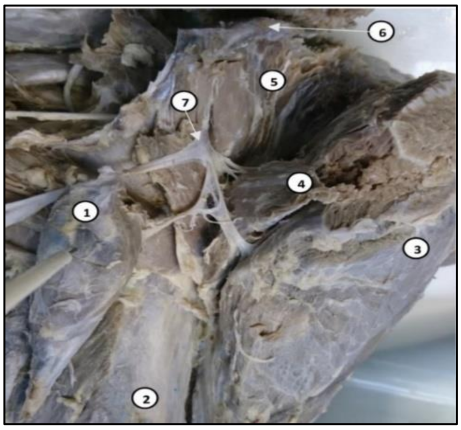


Figure 3.1.2. Muscles and nerves of the left pelvic limb, ventromedial view: *1 – M. pectineus, 2 – M. vastus medialis, 3 – M. adductor, 4 – M. adductor longus, 5 – M. external obturator, 6 – symphysis pelvina, 7 – N. obturatorius.* Piece by A. Dumitriu.

The lateral muscles of the pelvis were dissected as follows (figure 3.1.3;3.1.4):

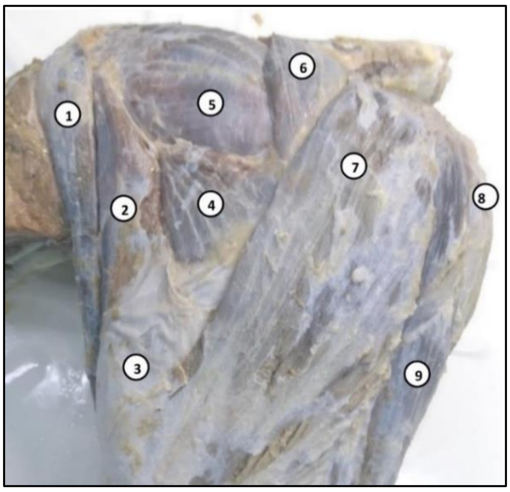


Figure 3.1.3. Superficial muscles of the left pelvic limb, lateral view: 1 – *M. sartorius, 2 – M. tensor fasciae latae (*cranial part*), 3 – fascia latae, 4 – M. tensor fasciae latae* (caudal part*), 5 – M. gluteus medius, 6 – M. gluteus superficialis, 7 – M. biceps femoris, 8 – M. semimembranosus, 9 – M. semitendinosus.* Piece by A. Dumitriu.

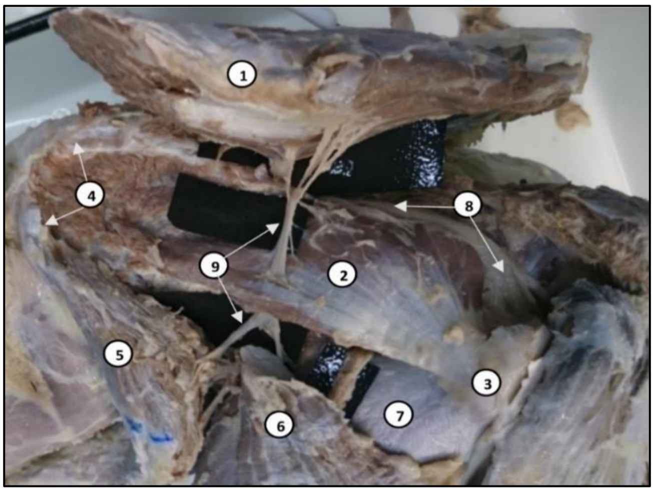


Figure 3.1.4. Gluteal muscles and adjacent formations of the left pelvic limb, lateral view: 1 – *M. gluteus medius, 2 – M. gluteus profundus*, 3 – insertion of *M. gluteus profundus* on the medial face of the greater trochanter, 4 – ischiatic crest, 5 – *M. tensor fasciae latae* (cranial part), 6 – *M. tensor fasciae latae* (caudal part), 7 – *M. vastus lateralis*, 9 – *N. gluteus cranialis.* Piece by A. Dumitriu.

Thus, the muscle masses of the pelvic limb in dogs are grouped by regions and systematized into: muscles of the pelvis, thigh muscles, shank muscles, and autopodium muscles. These anatomical formations have a supportive role, ensuring both triplanar mobility and joint stability through insertion on bony prominences.

The results obtained from these studies detail the specific anatomical and biomechanical parameters of the regional musculature that actuate the coxofemoral joint. The analysis of the conformation and biomechanics of the regional musculature, with determination of the fixed and mobile insertions of the muscles (figure 3.1.5), will help in understanding the role of each muscle in joint movements, including flexion, extension, abduction, adduction, and rotation. This will contribute to a better evaluation of motor function in dogs.

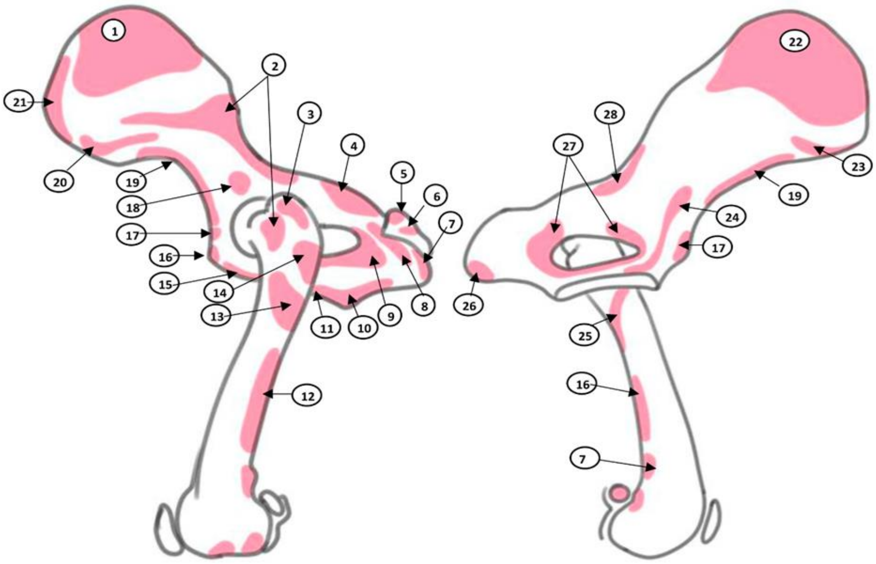


Figure 3.1.5. Muscular insertions involved in the biodynamics of the coxofemoral joint, lateral and medial view: *1 – M. gluteus medius, 2 – M. gluteus profundus, 3 – M. gluteus medius, 4 – M. gemelli, 5 – M. biceps femoris, 6 – M. semitendinosus, 7 – M. semimembranosus, 8 – M. quadratus femoris, 9 – M. obturatorius externus, 10 – M. adductor, 11 – M. gracilis, 12 – M. adductor, 13 – M. vastus lateralis, 14 – M. gluteus superficialis, 15 – M. rectus femoris, 16 – M. pectineus, 17 – M. psoas, 18 – M. rectus femoris, 19 – M. iliopsoas, 20 – M. tensor fasciae lata, 21 – M. sartorius, 22 – M. iliocostalis și M. longissimus lumborum, 23 – M. quadratus lumborum, 24 – M. levator ani, 25 – M. vastus medialis, 26 – M. ischiocavernosus, 27 – M. obturatorius internus, 28 – M. coccigeus.* Scheme after Barone, modified by A. Dumitriu.

Determination of pelvic muscle mass indices by the gravimetric method.Performing dissections, alongside gravimetry of the muscles adjacent to the coxofemoral region, qualitative research was also conducted on articular formations such as the femoral head, acetabular fossa, ligaments, and quantitative measurements of femoral bone length to observe various anatomical nonconformities. Changes were observed in 5 cadavers, such as femoral bone length and the presence of coxarthrosis with varying degrees of severity (table 3.1.1).

Table 3.1.1. The group of dysplastic dogs (cadavers), (n=5)

Ord. nr.	Sex	Race	Age (years)	Mass (kg)	Length, femur bone (cm)		Presence/absence of coxarthrosis	
					right	left	right	left
1	Female, spayed	Mixed race	3	9,7	**14,1**	**14,3**	-	-
2	Male, uncastrated	Golden Retriever	3,2	24	26,5	26,5	-	+
3	Male, castrated	German Shepherd	7	32	22,2	22,2	+	+
4	Female, unspayed	Beagle	3	10,5	**15,2**	**15,4**	-	-
5	Female, spayed	Mixed race	5	11	16,1	16,1	-	+

In table 3.1.2., the qualitative and quantitative characteristics of the group of dogs are presented, for which, following the inspection of the anatomical specimens, no structural abnormalities or morphometric deviations were observed. Thus, this non-dysplastic group served as a comparison tool.

Table 3.1.2. The group of non - dysplastic dogs (cadavers), (n=5)

Ord. nr.	Sex	Race	Age (years)	Mass (kg)	Length, femur bone (cm)		Presence/absence of coxarthrosis	
					right	left	right	left
1	Male, uncastrated	Mixed race	2	8,4	14,6	14,6	-	-
2	Female, unspayed	Mixed race	7	6,5	15,9	15,9	-	-
3	Male, uncastrated	Labrador	0,6	22,6	24,1	24,1	-	-
4	Male, uncastrated	Mixed race	3,5	6	16,4	16,4	-	-
5	Female, spayed	Mixed race	3	7	16,7	16,7	-	-

At the same time, the average muscle mass was calculated for each of the 29 muscles that mobilize the coxofemoral joint. In order to avoid duplicating figures and exclude errors, the *Mm. adductores* and medial and lateral *M. semimembranosus* were grouped into two categories respectively, and a single mass was calculated. The *M. caudal crural adductor* was also excluded, being a very thin muscle that adheres closely to the *M. biceps*, which could not always be separated. Thus, the number of muscles included in Table 3.1.3 is n=23.

Table 3.1.3. Average gravimetric parameters (g) of the muscle mass adjacent to the coxofemoral joint, (M±m)

Ord. nr.	The pelvic limb muscles involved in the hip joint	Mean muscle mass (n=5) nondysplastic		Mean muscle mass (n=5) dysplastic	
		right limb (g)	left limb (g)	right limb (g)	left limb (g)
1	*M. sartorius, cranialis*	12,22 ± 0,87	11,98 ± 0,87	22,81 ± 1,19 *	22,04 ± 1,17*
2	*M. sartorius, caudalis*	5,36 ± 0,58	6,20 ± 0,62	9,48 ± 1,77 **	9,84 ± 0,78**
3	*M. tensor fasciae latae*	11,28 ± 0,84	11,27 ± 0,84	21,00 ± 1,14 *	20,40 ± 1,12*
4	*M. biceps femoris*	58,26 ± 0,43	60,87 ±1,95	112,20 ± 2,64*	112,53 ± 2,65*
5	*M. gluteus superficialis*	5,31 ± 1,91	6,67 ± 0,65	10,34 ± 0,80*	11,58 ± 0,85**
6	*M. gluteus medius*	25,9 ± 0,58	26,44 ± 1,29	52,57 ± 1,81 *	50,04 ± 1,76*
7	*M. gluteus profundus*	4,68 ± 1,27	4,86 ± 0,55	7,85 ± 0,70 **	8,00 ± 0,70**
8	*M. semitendinosus*	20,9 ± 0,54	20,31 ± 1,13	41,37 ± 1,60 *	40,72 ± 1,59*
9	*M. semimembranosus*	34,66 ± 1,14	33,22 ± 1,44	77,75 ± 2,20 *	72,86 ± 2,13 *
10	*M. gracilis*	18,61 ± 1,47	20,08 ± 1,12	35,75 ± 1,49 *	35,92 ± 1,49*
11	*M. vastus lateralis*	20,01 ± 1,08	20,34 ±1,13	34,62 ± 1,47 *	28,91 ± 1,34**
12	*M. vastus intermedius*	18,89 ± 1,12	18,42 ± 1,07	35,14 ± 1,48 *	36,47 ± 1,5*
13	*M. vastus medialis*	21,91 ± 1,09	21,76 ± 1,17	39,41 ± 1,56 *	38,78 ± 1,55*
14	*M. rectus femoris*	23,09 ± 1,17	20,05 ± 1,12	35,42 ± 1,48 *	35,46 ± 1,48*
15	*M. adductor*	47,31 ± 1,20	48,68 ± 1,74	91,60 ± 2,39 *	87,67 ± 2,34 *
16	*M. pectineus*	3,54 ± 0,47	3,80 ± 0,49	6,46 ± 0,63 **	6,16 ± 0,62***
17	*M. quadriceps femoris*	3,57 ± 0,47	3,48 ± 0,46	5,72 ± 0,59***	5,66 ±0,59 ***
18	*M. piriformis*	3,59 ± 0,47	3,25 ± 0.45	5,74 ± 0,60***	5,58 ±0,59 ***
19	*M. adductor longus*	3,21 ± 0,44	3,52 ± 0,47	6,37 ± 0,63 **	6,24 ± 0,62**
20	*M. gemelli cranialis*	0,16 ± 0,10	0,20 ± 0,11	0,19 ± 0,10	0,21 ±0,11
21	*M. gemelli caudalis*	0,34 ± 0,14	0,23 ± 0,12	0,37 ± 1,52	0,34 ± 0,14
22	*M. obturatorius internus*	5,37 ± 0,58	5,5 ± 0,58	10,06 ± 0,80 *	10,58 ± 0,81*
23	*M. obturatorius externus*	5,22 ± 0,57	5,28 ± 0,57	8,44 ± 0,72 **	8,55 ± 0,73**
	Total	356,52 ±4,72	358,39 ± 4,73	673,88 ± 6,49*	657,82 ±6,41*

*p<0,001;**p<0,01;***p<0,05.

From the data presented, it is observed that the muscle mass of the muscles directly participating in the biomechanics of the coxofemoral joint in the nondysplastic group (n=5) has similar values. The right limb shows a mean value of 356,52 ± 472 g, and the left limb 358,39 ± 4,73 g, which constitutes 3,27% and 3,31% of the total mean mass of the aforementioned muscles, respectively, with a difference of 0,04%.

In the case of the dysplastic group, the muscle mass adjacent to the coxofemoral joint in the right limb indicates a value of 673,88 ± 6,49 g ($p < 0.001$), and the left limb 657,82 ± 6,41 g ($p < 0,001$), constituting 3,73% and 3,63% of the total mean mass of the aforementioned muscles, respectively, with a difference of 0,1%.

Table 3.1.4. Mean gravimetric parameters (g) of the muscle mass adjacent to the coxofemoral joint under innervation by the femoral nerve (M ± m)

Nerves for the muscle group	**Muscles adjacent to the joint under innervation**	**Mean muscle mass (n=5) nondysplastic**		**Mean muscle mass (n=5) dysplastic**	
		limb right (g)	**limb left (g)**	**limb right (g)**	**limb left (g)**
N. femoralis	*M. sartorius* cranial part	13,61 ±0,92	10,67 ±0,82	22,81 ±1,19*	22,04 ±1,17 *
	M. sartorius caudal part	6,03 ±0,61	6,20 ±0,62	9,48 ±0,77**	9,84 ±0,78 **
	M. vastus lateralis	22,74 ±1,19	20,34 ±1,13	34,62 ±1,47 *	28,91 ±1,34 **
	M. vastus intermedius	20,24 ±1,12	18,42 ±1,07	35,14 ±1,48 *	36,47 ±1,51 *
	M. vastus medialis	24,06 ±1,23	21,76 ±1,17	39,41 ±1,57 *	38,78 ±1,56 *
	M. rectus femoris	27,09 ±1,30	20,05 ±1,12	35,42 ±1,49 **	35,46 ±1,49 *
Total muscle mass		113,76 ±2,67	97,44 ±2,47	176,89 ±3,32 *	171,50 ±3,27 *
GMMI, %		36,20 ±1,50	27,29 ±1,31	26,45 ±1,29 *	26,02 ±1,28
PMMI, %		4,75 ±0,06	4,30 ±0,06	7,94 ±0,70 **	7,75 ±0,70 **

*p<0,001;**p<0,01.

Analyzing the data from table 3.1.4, it can be stated that the femoral nerve exerts an action upon a pelvic muscle mass with a mean value of 105.6 g (0.95% of the total mass) in the nondysplastic group and 174,2 g ($p < 0,001$), (0,97% of the total mass) in the dysplastic group, the difference being insignificant at 0.02%. The muscle group innervated by the femoral nerve was one of the most massive, contributing 26,21% ± 1,2% on the right side and 25,98% on the left in the pelvic muscle mass of the dysplastic group, and 28,17% and 26,63% in the pelvic muscle mass of the nondysplastic group, respectively. The pelvic muscle mass index (PMMI) was on average 4,52%, with differences of 0.45% between the right and left limb values of the pelvic muscle mass in the nondysplastic group and 7,84% ($p < 0,001$) in the dysplastic group. The group muscle mass index (GMMI) in the nondysplastic group was on average 31,74% and 26,23% ($p < 0,001$) in the presumed dysplastic group, constituting a difference of 5,51%.

The data presented in the thesis demonstrate that the cranial gluteal nerve and the caudal gluteal nerve exert the least action upon a pelvic muscle mass with a mean value of 0.51% of the total cadaver mass in both groups.

Table 3.1.5. Mean gravimetric parameters (g) of the muscle mass adjacent to the coxofemoral joint under innervation by the sciatic nerve (M ± m)

Nerves for the muscle group	Muscles adjacent to the joint under innervation	Mean muscle mass (n=5) Nondysplastic		Mean muscle mass (n=5) Dysplastic	
		right limb (g)	left limb (g)	right limb (g)	left limb (g)
N. ischiadicus	*M. biceps femoris*	63.48 ±1.99	60.87 ±1.95	112.20 ±2.65*	112.53 ±2.65 *
	M. semitendinosus	23.10 ±1.20	20.31 ±1.13	41.37 ±1.61*	40.72 ±1.60 *
	M. semimembranosus	37.30 ±1.53	33.22 ±1.44	77.75 ±2.20*	72.86 ±2.13 *
	M. quadratus femoris	3.92 ±0.50	3.48 ±0.47	5.72 ±0,60	5.66 ±0.59***
	M. gemelli cranial	0.18 ±0.10	0.20 ±0.11	0.19 ±0.11	0.21 ±0.11
	M. gemelli caudal	0.36 ±0,15	0.24 ±0.12	0.37 ±0.15	0.34 ±0.15
	M. obturatorius internus	5.75 ±0,60	5.50 ±0,60	10.06 ±0.79**	10.59 ±0,8 1*
Total muscle mass		134.09 ±2.89	123.81 ±2.78	247.66 ±3.93*	242.92 ±3.90 *
GMMI, %		37.37 ±1,53	32.53 ±1.43	36.09 ±01.50	36.75 ±1,52
PMMI, %		4,75 ±0,06	4,30 ±0,06	7,94 ±0,70 **	7,75 ±0,70 **

*p<0,001;**p<0,01;***p<0,05.

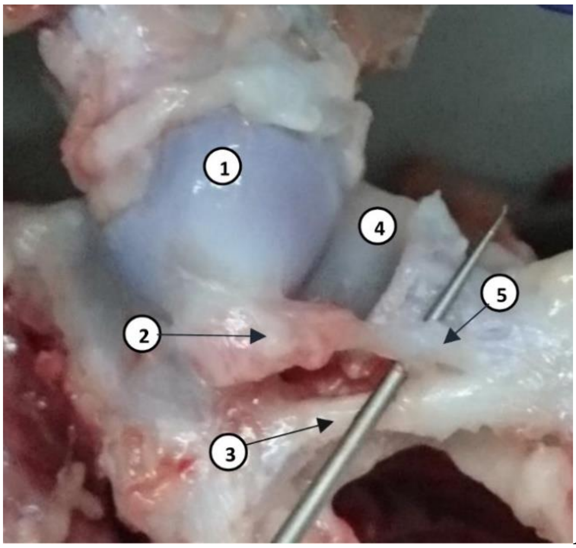
Analyzing the data from table 3.1.5, it can be stated that the sciatic nerve exerts the greatest action upon a pelvic muscle mass with a mean value of 128,9 g in the nondysplastic group and 245,29 g ($p < 0,001$) in the presumed dysplastic group. The muscle group innervated by the sciatic nerve is the most massive, contributing 36,70% on the right side and 36,87% on the left in the pelvic muscle mass of the dysplastic group, and 33,20% and 33,83% in the pelvic muscle mass of the nondysplastic group, respectively. The group muscle mass index (GMMI) in the nondysplastic group was on average 34,95% and 36,42% in the presumed dysplastic group, constituting a difference of 1.47%.

In parallel with the dissection of the hip region muscles from the exterior to the depth, the investigation of the joints in the coxofemoral region was conducted. The ischium and pubis bones unite in the median plane at the level of the pelvic symphysis, which was extremely difficult to dissect in senile specimens.

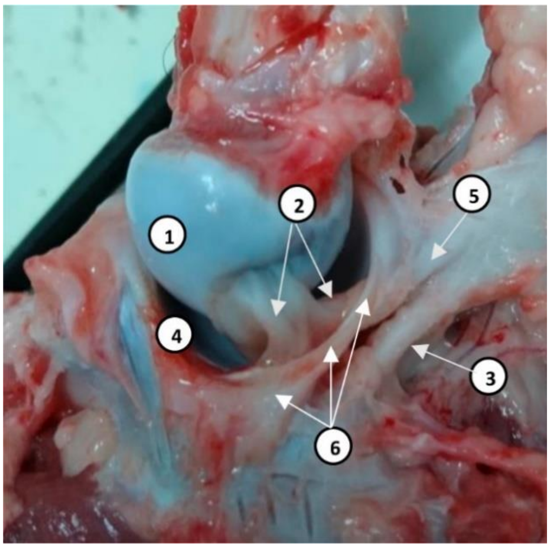
The sacroiliac joint is oriented more towards stability than mobility. In adult dog cadavers, most of the articular surfaces were united by fibrocartilage, surrounded by hyaline cartilage containing synovial fluid.

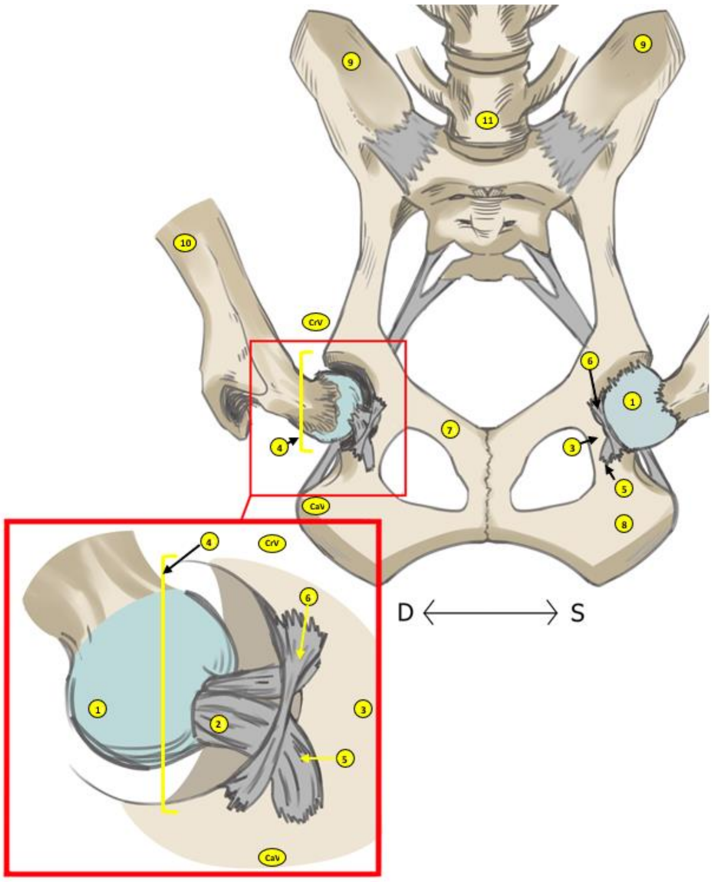
The hip joint is a spheroidal joint, whose main movements are flexion and extension. The movements of this joint are limited by the opposing action of the medial and lateral rotator muscles. The articular capsule can be observed from the level of the femoral neck up to the peripheral line opposite the acetabular rim.

After removing the articular capsule, the ligament of the femoral head became visible and could be anatomically studied. The transverse acetabular ligament was subsequently removed to allow better visualization of the insertions and continuity of the ligament of the femoral head. Finally, in the anatomical specimens subjected to conservation, the ligament of the femoral head was meticulously excised to allow further analysis of its orientation towards insertions and visualization of its fascicles (figure 3.1.6, A, B).



A ....B





Scheme after A. Dumitriu

Figure 3.1.6. Structural peculiarities of the canine hip joint, (A, B - fresh macropreparation): *1 – caput ossis femoris, 2 – Ligamentum capitis ossis femoris* cu inserție extracapsulară, cranio-ventrală pe corpul ischiumului, 3 – porțiunea ischio-pubiană a pelvisului, 4 – *fossa acetabuli*, 5 – inserția extracapsulară a *lig. capitis femoris*, 6 – *ligamentum transversum acetabuli, 7 – os pubis, 8 – os ischii, 9 – os ilium, 10 – os femoris, 11 – L7,* CrV – cranioventral, CaV – caudoventral. Piece prepared by A. Dumitriu.

Examining the ligamentous structures of the coxofemoral joint, it was found that the *Ligamentum capitis ossis femoris*, as described, is not the only structure that adheres to the *Fossa acetabuli*, as is generally accepted and described in the specialised literature. It also adheres to the Ligamentum transversum acetabuli and is complemented by a "strong accessory ligament" (also described by authors Casteleyn, C. et al., 2015), which extends caudally to attach to the acetabular crest through the notch and extends extracapsularly on the cranio-ventral surface of the body of the ischium.

3.2. Sources of vascularization and architecture of the vascular bed of the coxofemoral region

To perform the analysis of the vascular bed, a group of 14 specimens was investigated using injection methods. These specimens varied in breed (mixed breeds), sex, age, and body weight ranging from 7 to 35 kg. Groups with small body mass were used for studying the vascular bed and its variations through corrosion methods. Groups with greater weight were used for the injection method with contrast substances and imaging investigations.

In dogs, the terminals of the abdominal aorta bifurcate at the level of the lumbosacral joint into five branches (Figure 3.2.1), as follows: *A. iliaca externa dextra* and *A. iliaca externa sinistra*, *A. iliaca interna dextra* and *A. iliaca interna sinistra*, and *A. sacralis mediana*.

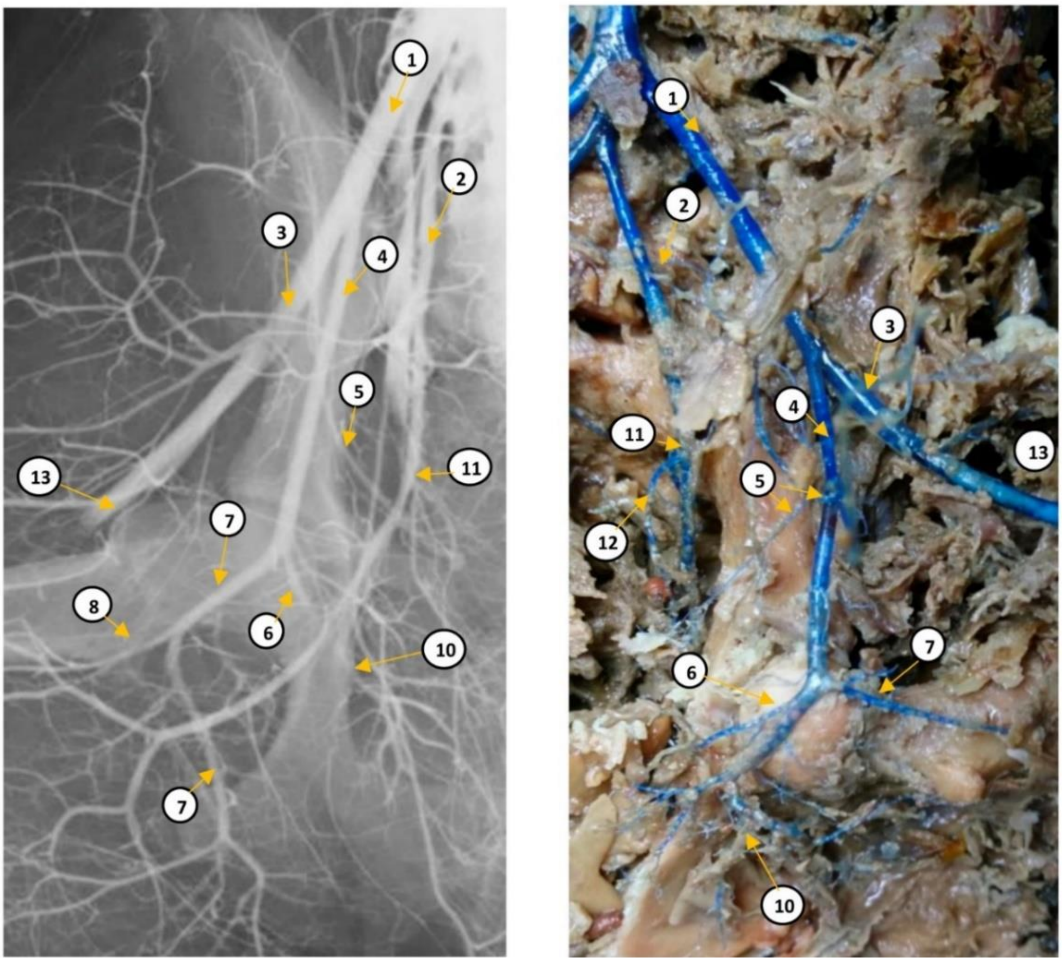


Figure 3.2.1. Arteries of the coxofemoral region in the dog, right/left ventral view (A, B): *1 – a. iliaca externa, 2 – a. iliaca interna, 3 – a. profunda femoris, 4 – a. circumflexa femoris medialis, 5 – ramus obturatorius, 6 – ramus acetabularis, 7 – ramus transversus, 8 – ramus profundus, 9 – ramus transversus, 10 – ramus ascendens, 11 – a. glutea caudalis, 12 – a. glutea cranialis, 13 – a. femoralis.* A – imaging method with contrasting substances, B – macropreparation, corrosion method. Pieces made by A. Dumitriu.

When the external iliac artery traverses the abdominal wall, it becomes the *A. femoralis*. The deep femoral artery (*A. profunda femoris*) is the only branch of the external iliac artery; it appears inside the abdominal cavity, and the passage occurs at the level of the vascular lacuna, which is located between the caudal edge of the abdominal aponeurosis of the external oblique muscle and the pelvis.

The branches of the femoral artery, important in the coxofemoral region and in the order in which they appear, are: *a. circumflexa ilium superficialis*, *a. circumflexa femoris lateralis*, and *a. caudalis femoris proximalis* (figures 3.2.1; 3.2.2.).

Analysis of the research indicates that the extracapsular blood supply of the dog's coxofemoral joint is facilitated by branches of the following arteries: *a. circumflexa femoris medialis* with its branches – *ramus obturatorius, ramus acetabularis, ramus ascendens; a. circumflexa femoris lateralis* with its branches *ramus ascendens, ramus descendens* and *ramus transversus; a. glutea caudalis* and *a. glutea cranialis* (figure 3.2.2).

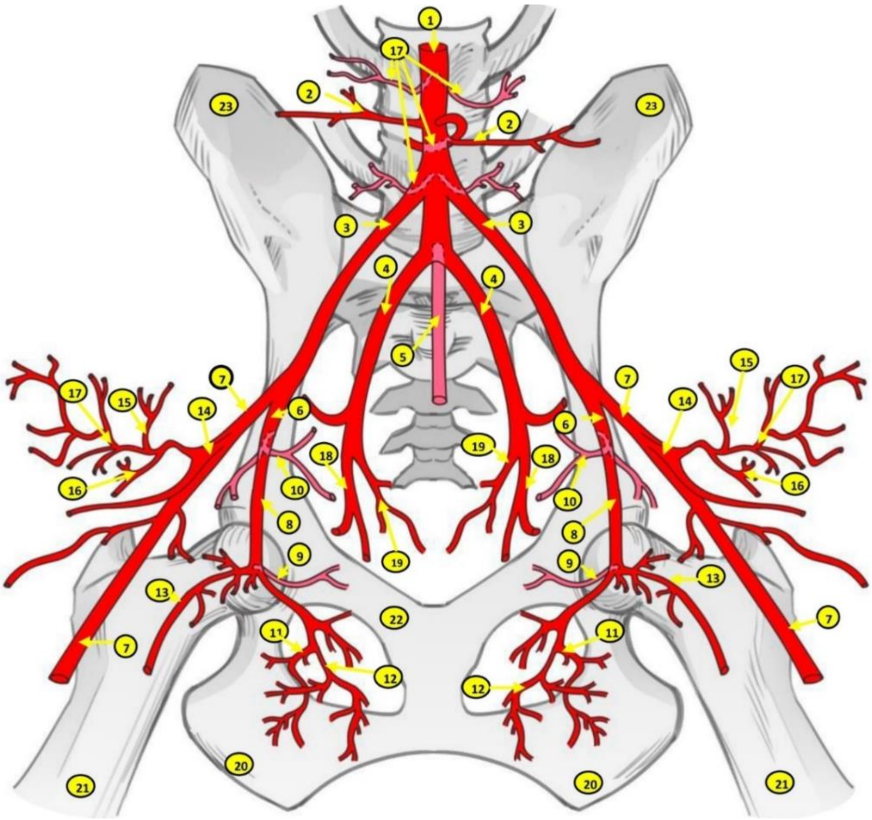


Figure 3.2.2. Arteries of the coxofemoral region in the dog: *1 – Aorta abdominalis, 2 – a. circumflexa ilium profunda, 3 – a. iliaca externa, 4 – a. iliaca interna, 5 – a. sacralis mediana, 6 – a. profunda femoris, 7 – a. femoralis, 8 – a. circumflexa femoris medialis, 9 – ramus acetabularis, 10 – ramus obturatorius, 11 – ramus ascendens, 12 – ramus profundus, 13 – ramus transversus, 14 – a. circumflexa femoris lateralis, 15 – ramus ascendens, 16 – ramus descendens, 17 – ramus transversus, 18 – a. glutea caudalis, 19 – a. glutea cranialis, 20 – os ischii, 21 – os femoris, 22 – os pubis, 23 – os ilium.* Scheme, after A. Dumitriu.

The data indicate that the sources of vascular supply to the dog's coxofemoral joint, from most to least contributive, are the branches of the *a. circumflexa femoris lateralis a. circumflexa* *femoris medialis*, which originate from *a. femoralis* and *a. profunda femoralis,* respectively. The arteries*a. glutea caudalis and a. glutea cranialis,* which also supply the coxofemoral joint, originate from the a. iliaca interna.

3.3. Sources of innervation and distribution of nerves in the coxofemoral region

Studying the innervation and nerve distribution of the canine pelvic limb, especially the hip joint region, is increasingly relevant in treating various co-occurring conditions.

Distribution of Innervation Sources of the Coxofemoral Joint. The nerves of the hip region and the coxofemoral joint are somatic spinal nerves originating from the *Plexus lumbalis caudalis and Plexus sacralis cranialis.*

The lumbosacral plexus consists of nerves from two portions: the anterior portion with n. iliomuscularis, n. femoralis, and n. obturatorius, and the posterior portion with n. gluteus cranialis, n. gluteus caudalis, n. cutaneus femoris caudalis, and n. ischiadicus (figures 3.3.1; 3.3.2).

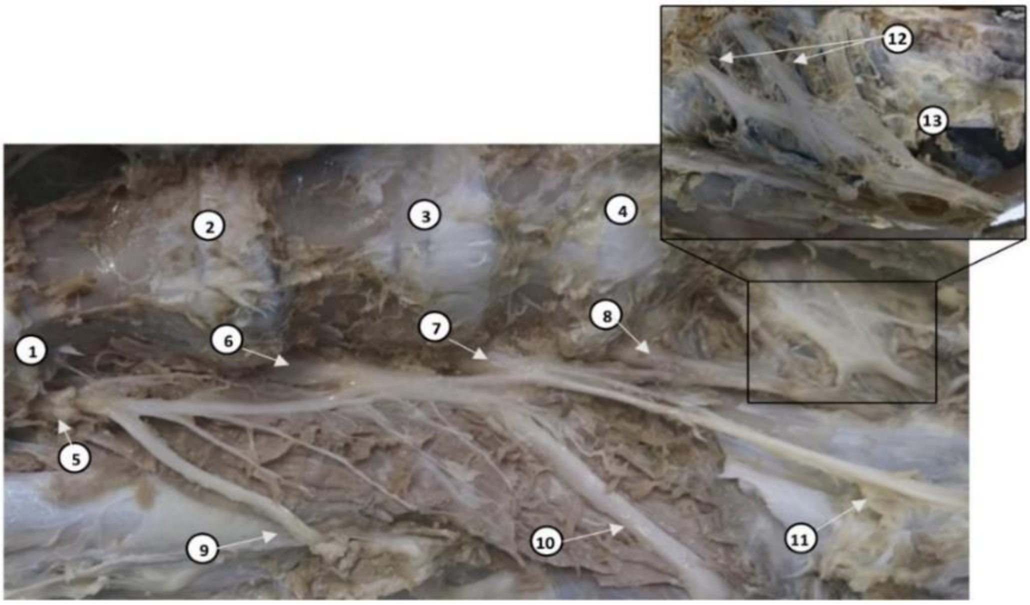


Figure 3.3.1. Lumbosacral plexus in the dog: *1 – L4, 2 – L5, 3 – L6, 4 – L7, 5, 6, 7 – roots of the caudal lumbar plexus, 8 –* root of *N. ischiadicus, 9 – N. cutaneus femoris lateralis, 10 – N. femoralis, 11 – N. obturatorius, 12 –* roots of the sacral plexus, *13 – N. ischiadicus.* Anatomical dissection after Vorobiov. Piece prepared by A. Dumitriu.

N. femoralis was observed in 71,5% of cases with two main roots from L4 and L5, and in 28.5% from the sixth spinal nerve L6. Connections with the L3 nerve appeared in 14,2% of cases. It emerges at the level of the iliopsoas muscle, to which it also provides branches. Within the iliopsoas, from the cranial part of the femoral nerve, it continues as the saphenous nerve.

N. femoralis is the largest nerve arising from the caudal lumbar plexus and predominantly motor, terminating in the quadriceps femoris muscle. It is responsible for knee extension to support weight in the pelvic limb.

N. ischiadicus as it emerged from the caudal portion of the lumbosacral plexus. Appearing as a thick, flattened cord, it exited the pelvic cavity at the greater ischiatic notch and passed over the dorsal surface of the sacrospinotuberous ligament, beneath the middle gluteal muscle. At this level, it connected with n. pudendus and n. rectalis.

The *N. obturatorius* originates from the ventral roots of L4, L5, and L6. It is much thinner than the femoral nerve. It forms within the caudomedial portion of the m. iliopsoas. Exiting the muscle dorsomedially, it passes caudoventrally along the body of the ilium. A subperitoneal course at the anterior margin of the semipennate portion of the internal obturator muscle (m. obturator internus) was observed, then moving towards the cranial part of the obturator foramen, through which it leaves the pelvic cavity alongside the homonymous artery and vein.

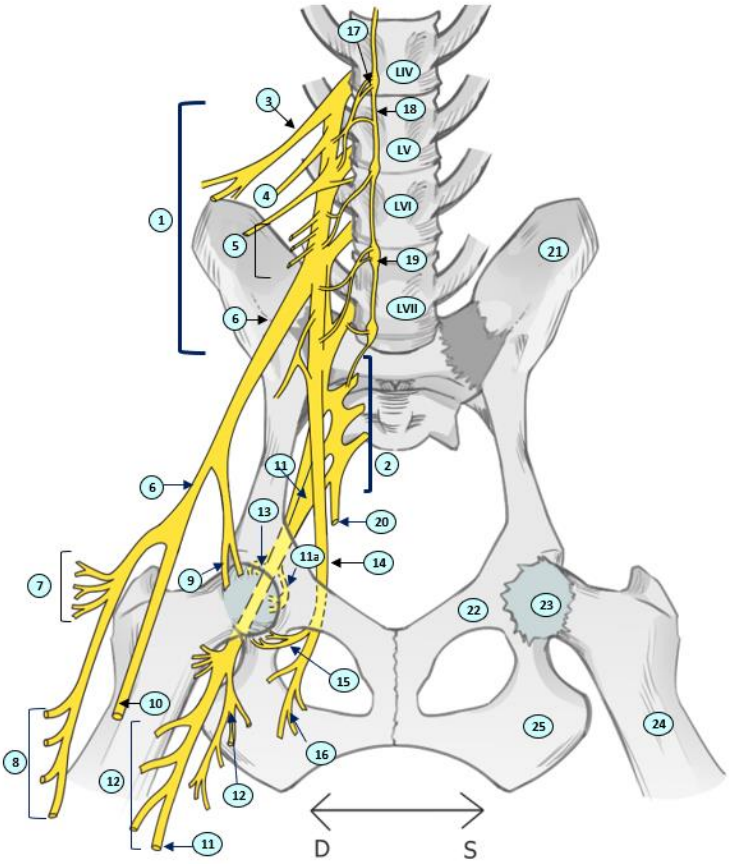


Figure 3.3.2. Distribution of nerves in the coxofemoral region of the dog: *1 – Plexus lumbalis caudalis, 2 – Plexus sacralis cranialis, 3 – N. cutaneus femoris lateralis, 4 – N. genitofemoralis, 5 – N. iliomuscularis, 6 – N. femoralis, 7, 8 – N. femoralis muscular branches, 9* – nerve branches of *N. femoralis* to the coxofemoral joint, *10 – N. saphenus, 11 – N. ischiadicus, 11a* – nerve branches of *N. ischiadicus* to the coxofemoral joint, 12 – *N. ischiadicus Rami musculares, 13 – N. gluteus cranialis, 14 – N. obturatorius, 15* – nerve branches of *N. oturatorius* to the coxofemoral joint, 16 – *N. obturatorius, Rami musculares, 17 –* orthosympathetic fibers, communicating branches, *18* – parasympathetic paravertebral chain, 19 – orthosympathetic ganglion, *20 – N. pudendus, 21 – os ilium, 22 – os pubis, 23 – Caput ossis femoris, 24 – os femoris, 25 – os ischii, L IV, V, VI, VII* – vertebrae L4, 5, 6, 7. Scheme, after A. Dumitriu.

Distribution of innervation sources at the articular capsule level. The innervation sources of the coxofemoral joint capsule were highlighted using fine anatomical dissection methods, after Vorobiov (Vorobiev V.P., 1958) and tissue staining with methylene blue after Erlich–Dogel. The results of the research show that nerve branches penetrate the fibrous formations of the bones and their components at the muscle insertion points, accompanying blood vessels (figure 3.3.3).

According to the anatomical dissections, nerve branches of *N. gluteus cranialis* consistently penetrate the craniolateral portion of the canine hip joint capsule. The caudolateral portion is innervated by the muscular branches of *N. ischiadicus*, with some individual variations. *N. femoralis* gives off articular branches to the cranioventral portion of the capsule. *N. obturatorius* sends short articular branches to the caudoventral portion. Branches from these four main nerves contribute to the circumferential innervation of the canine hip joint capsule. In this study, larger canine cadavers revealed more nerve branches. The branches of *N. gluteus caudalis* were not found to participate in the innervation of the coxofemoral joint capsule.

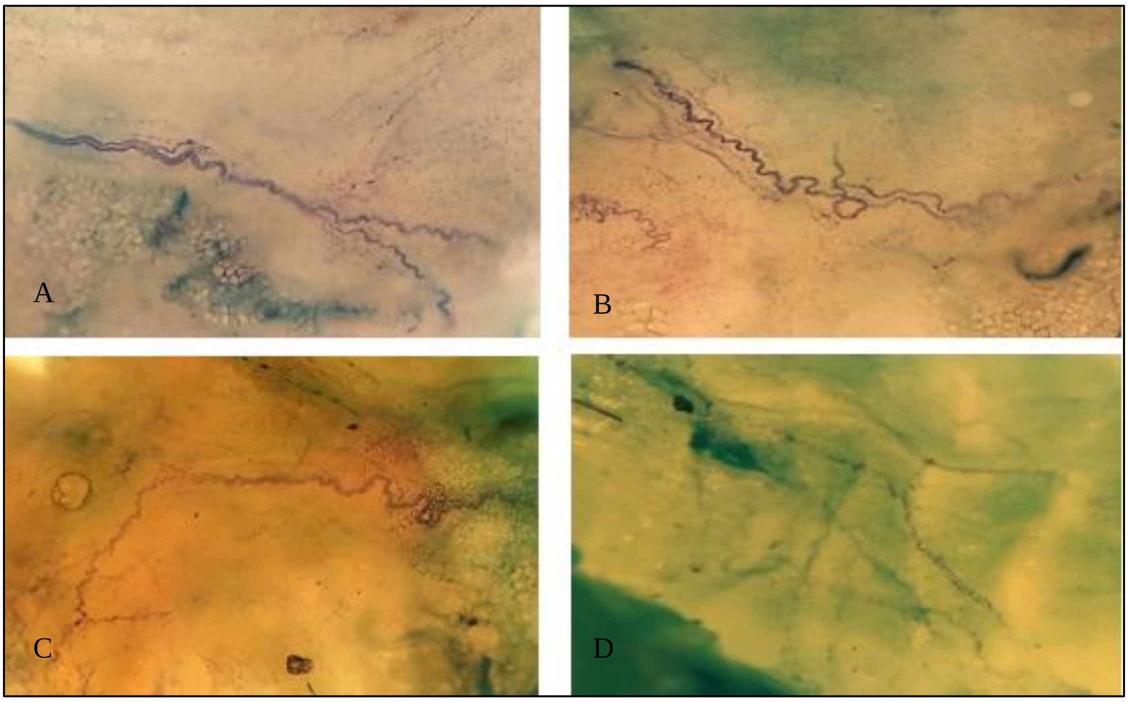


Figure 3.3.3. Distribution of nerves at the level of the coxofemoral joint capsule (A, B, C, D): free nerve endings, A – cranioventral region – *N. femoralis*; B – caudoventral region – *N. obturatorius,* C – craniolateral region – *N. gluteus cranialis*, D – caudolateral region – *N. ischiadicus.* Original micropreparation using the Erlich – Dogel method.

4. RESEARCH ON RADIOLOGICAL EXAMINATION FOR EARLY DIAGNOSIS OF HIP JOINT DYSPLASIA IN DOGS

Both primary and secondary dysplasia lead to abnormal functionality and deficient biomechanics in the coxofemoral joint [19, 22, 23].

According to data published by International Canine Clubs, purebred dogs of large and giant breeds are predisposed to this degenerative disease, less so medium breeds. To be eligible for breeding, owners must have a report indicating the degree of dysplasia, issued by an authorized expert, in accordance with classifications approved by various international kennel organizations (FCI, OFA, BVA/KC, 2024).

When dysplasia symptoms appear in non-breeding dogs without a pedigree, veterinarians need to diagnose and determine the severity of the pathology using imaging techniques for radiographic measurement to diagnose and evaluate the degree of hip dysplasia in dogs.

According to the protocol published by FCI and BVA, AIS, OFA (2024), the minimum age for official hip radiographs is at least one year for most breeds and 18 months for large and giant breeds.

Nationally, each FCI member or contractual partner should provide an appeal procedure. The dog owner can file an appeal, but it cannot be processed by the examiner or panel that initially scored the dog. The appeal evaluation must be based on the radiograph from the first scoring. The owner may submit, and the appeal committee may request, additional radiographs (including position 2). Radiographs must be evaluated equally, except for dogs with lax hip joints, where the FCI stipulates that the score should be based on the set showing the greater degree of joint laxity. The decision of the appeal procedure is final.

FCI recommends all its members, contractual partners, and bodies organizing screening programs to facilitate the participation of their scoring committee members in an official FCI program for balancing CHD scores through international standardizations.

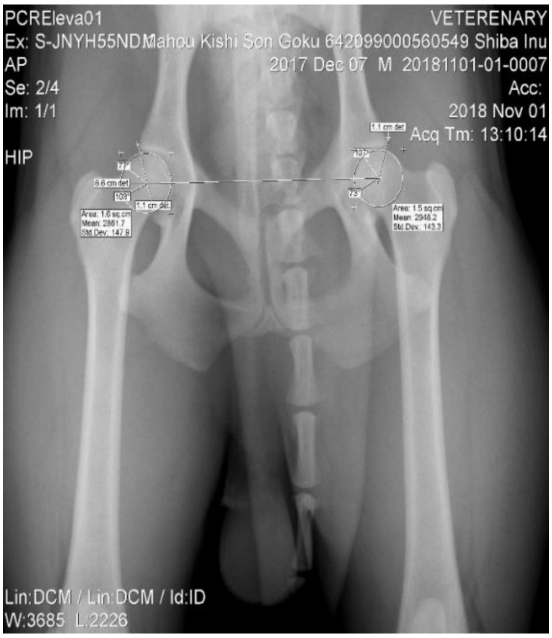
4.2. Measurement of hip joint parameters in dogs for diagnosis and evaluation of dysplasia degree

The research involved the examination of 57 radiographic images from patients of various ages, sexes, and breeds. Examinations were conducted at the EsculapVet-Vasile Buza Veterinary Center, the University Veterinary Medical Center of UTM, and the Royal Vet Veterinary Clinic in Brăila, Romania. The radiological examination of the hip joints was performed using digital installations: Philips PCRElevaF, "Mex+40", tube No. 2E1029C, a/f 2022, A2131, G2092, and EXAMION Maxivet DR with direct conversion technology.

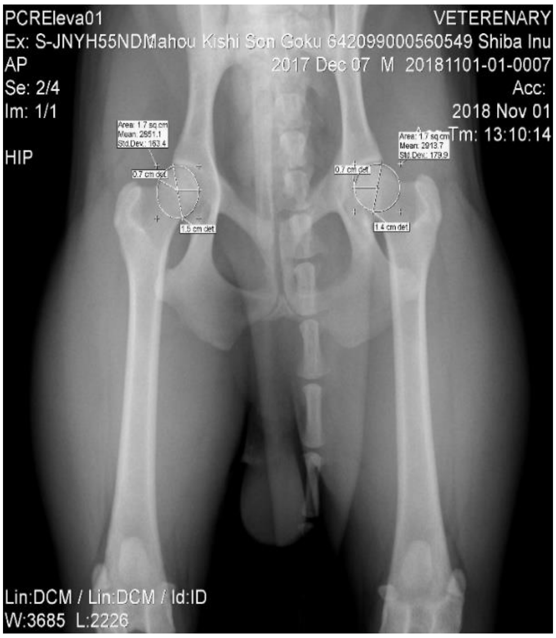
Figure 4.2.1. Correct positioning of animals during X-ray examination.

Digital radiological cassettes with dimensions of 53.4 x 53.4 cm and 35.4 x 43.0 cm were used. For proper fixation of the animal, a special table was utilized, allowing the thoracic and lumbar regions of the patient to be secured in the desired position (figure 4.2.1). The radiation exposure settings were adjusted considering the thickness of the examined area in centimeters.

The animal was positioned in dorsoventral decubitus on the examination table. The cranial part of the body was fixed using the examination table, the hind limbs were placed caudally, parallel to each other, and an internal rotation of approximately 15 degrees was performed. The imaging area should include at least two lumbar vertebrae and the knee joints. For accurate evaluation, the radiograph must be clear and contrast-enhanced (figures 4.2.1 – 4.2.3).

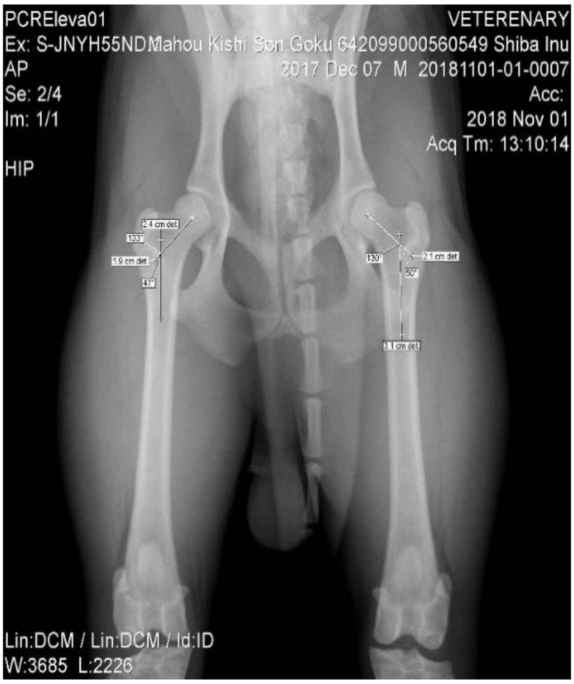


A – Measurement of the Norberg angle



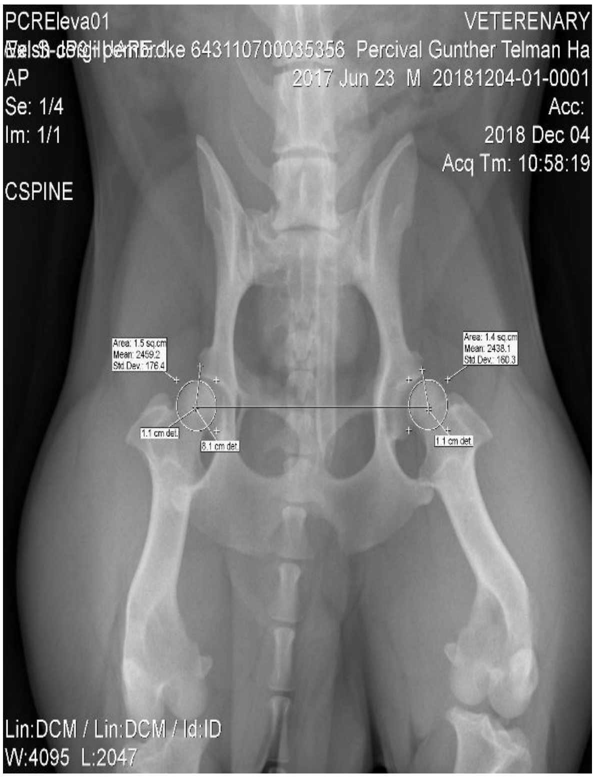
B – Measurement of the tangential angle

C – Determination of femoral head laxity

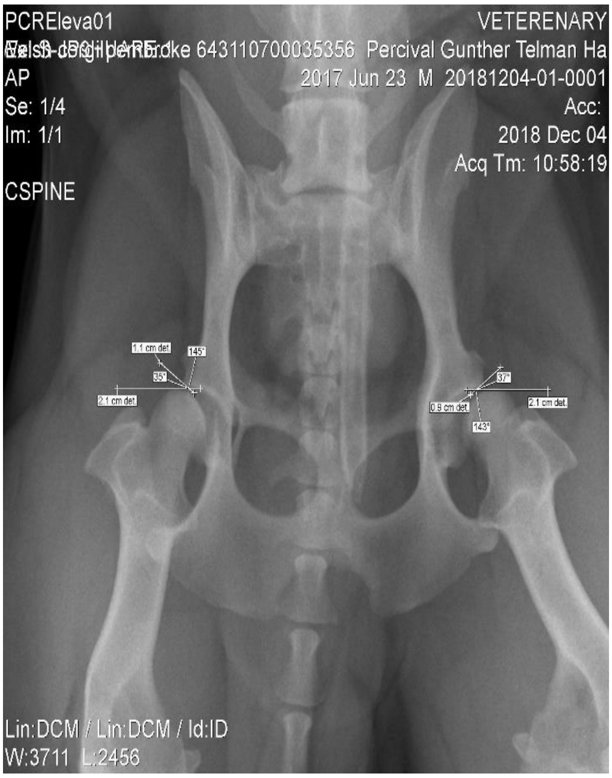


D – Determination of the cervico-diaphyseal angle

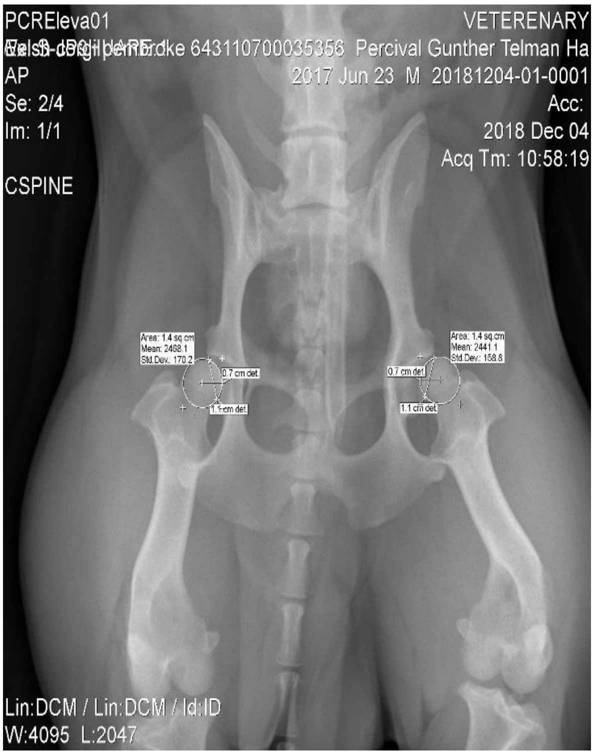
Figure 4.2.2. Determination of radiological parameters for diagnosing and evaluating the degree of dysplasia in dogs, *Shiba-Inu breed,* (A, B, C, D).



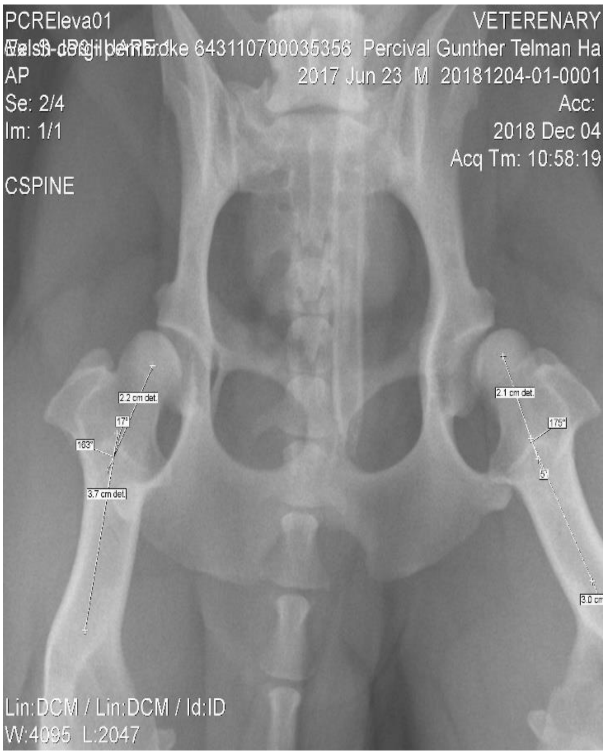
A – Measurement of the Norberg angle



B – Measurement of the tangential angle



C - Determination of femoral head laxity



D - Determination of the cervico-diaphyseal angle

Figure 4.2.3. Determination of radiological parameters for diagnosing and evaluating the degree of dysplasia in the *Welsh Corgi Pembroke breed,* (A, B, C, D).

Measurements of six parameters were performed, with a quantitative evaluation of the obtained score, expressed in points for each radiological sign, according to the evaluation system by Flückiger, M. (2007).

By interpreting the obtained images, patients were assigned a degree of dysplasia based on the score allocated to each qualitative criterion. This allowed for the assessment of the degree of dysplasia by analyzing the results in the studied subjects. The grades were defined descriptively based on the values of the Norberg angle (NA), the degree of subluxation, the shape and depth of the acetabulum, and signs of secondary joint disease (figures 4.2.2; 4.2.3). The classification was adopted for older dogs, and secondary arthritic changes were evaluated according to the dog's age. The following images were evaluated based on qualitative criteria, which were then converted into quantitative criteria.

By analyzing and interpreting the obtained data, the degree of hip dysplasia was evaluated in *Shiba Inu* and *Welsh Corgi Pembroke* dogs based on qualitative and quantitative criteria and parameters (table 4.2.1; 4.2.2). The dogs were assigned dysplasia grades B (suspected case) and D (moderate dysplasia), respectively, showing a score difference of 14 points.

Table 4.2.1. Evaluation of hip dysplasia degree, dog, *Shiba Inu* breed

	Left hip joint	**No. of points**	**Right hip joint**	**No. of points**
Norberg Angle	107^0	0	103^0	4
Laxity	=1	1	=1	1
TG angle	negative	0	negative	0
State of the acetabular acavity plate	lateral – slightly thickened, medial – slightly reduced	2	uniformly thickened	1
Shape of the head and architecture of the femur	round head, unclear contour, non-uniform architecture	1	round head, unclear contour, non-uniform architecture	1
Exostoses on the neck	indistinct	0	indistinct	0
Sum of points		4		4
Degree of dysplasia		**B**		**B**

Table 4.2.2. Evaluation of hip dysplasia degree, dog, *Welsh Corgi* breed

	Left hip joint	**No. of points**	**Right hip joint**	**No. of points**
Norberg Angle	79^0	5	81^0	4
Laxity	=0,71	3	=0.7	3
TG angle	positive, edge strongly rounded, contours clearly separated	4	positive, edge strongly rounded, contours clearly separated	4
State of the acetabular cavity plate	lateral – strongly thickened, medial complete reduction	4	fused with the lateral surface of the pelvis	5
Shape of the head and architecture of the femur	round head, unclear contour, non-uniform architecture	1	round head, unclear contour, non-uniform architecture	1
Exostoses on the neck	indistinct, neck is cylindrical, transition without changes	1	indistinct, the neck is cylindrical, the transition without changes	1
Sum of points		18		18
Degree of dysplasia		**D**		**D**

Radiological investigation is the most indicated and informative method for diagnosing hip joint dysplasia in dogs. To obtain an accurate radiograph, it is important to adhere to radiographic technical parameters such as anode current, exposure time, applied voltage, and focal distance.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

1. The results of the morphometric research reveal that the mass of muscles involved in the biodynamics of the coxo-femoral joint, in relation to the body mass of the animals, in the non-displastic group is 3,27% – on the left and 3,31% – on the right, the difference being 0,04%. In the dysplastic group, this ratio is 3,73% – on the left and 3,63% – on the right, showing a disproportionality of 0,1%, which over time leads to worsening of hip dysplasia syndrome.

2. The *A. iliaca externa* was found to originate from the terminal segment of the abdominal aorta, branching at different levels as follows: at the caudal end of the L5 vertebra and the cranial end of the L6 – 14.28%; at the body of the L6 vertebra – 35.71%; at the caudal end of the lumbar L6 vertebra and the cranial end of the L7 – 50%. The presence of the common biiliac trunk was found in 85% of the investigated cadavers, and the symmetry of *A. circumflexa ilium profunda* was established in 14% of the cases.

3. The arteries that supply the craniomedial region and adjacent formations of the joint capsule are branches of *A. circumflexa femoris medialis*; the craniolateral region is supplied by *A. circumflexa femoris lateralis* and *A. glutea cranialis*; the caudolateral region is vascularized by *A. circumflexa femoris medialis*, *A. circumflexa femoris lateralis*, and *A. glutea caudalis*; and the caudomedial region by *A. circumflexa femoris lateralis*. The articular branches of these vessels approach and adhere to the joint capsule wall at the insertion site on the femur and hip bone.

4. Sources of innervation of the muscles involved in the biodynamics of the hip joint are*N. gluteus cranialis* and *N. gluteus caudalis; N. ischiadicus, N. femoralis, N. obturatorius*, and *N. cutaneus femoris caudalis*. The joint capsule in the cranioventral direction is innervated by branches of *N. femoralis*, caudoventral by *N. obturatorius*, craniolateral by *N. gluteus cranialis*, and caudolateral by *N. ischiadicus*. The nerve branches penetrate the fibrous formations of the bones and their components at the site of muscle insertion on the bone, being satellites of the blood vessels.

5. The results of radiologic examination, as the main method of diagnosis of coxo-femoral dysplasia in dogs, performed on 57 patients (31,57% – female and 68,42% – male), indicate the variation in the degree of dysplasia, as follows: grade 1 – 3,5%; grade 2 – 36,8%; grade 3 – 43,8% and grade 4 – 14,3%, which suggests a concern for the functional status of the coxo-femoral joint of the diagnosed subjects.

6. Analyzing the incidence of hip dysplasia on radiographic images, it was found that 26,3% of subjects had bilateral dysplasia, while unilateral cases were relatively evenly distributed: 33,3% on the left and 35% on the right. These data highlight the importance of early monitoring and evaluation of hip joint health, especially among dog breeds predisposed to dysplasia.

PRACTICAL RECOMMENDATIONS

1. Owners of dog kennels should be aware of the importance of radiologic examination of parental dogs for the early diagnosis of hip dysplasia by determining the Norberg angle values. Thus, parental lines showing an amount of 10 points or greater should not be accepted for breeding.

2. The structural interpretation of the sources of vascularization and innervation presents essential anatomic-clinical and therapeutic interest in dogs with hip dysplasia or arthrosis. The information obtained provides detailed data about the topography of pathways and distribution of blood vessels and nerves. Implementing these data in practice requires an analysis of possibilities for pain reduction and potential surgical interventions in the hip joint region in dogs.

3. During the x-ray examination of the coxofemoral joints, it is recommended to properly fix the animal, following the preparation protocol, ensuring adequate muscle relaxation to obtain an accurate radiographic evaluation.

4. It is recommended that the results of this research be considered in the educational process in related disciplines: Comparative Anatomy, Veterinary Semiology, Veterinary Radiology and Imaging, and Surgery.

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ADNOTARE

DUMITRIU Antonina. Aspecte anatomo-clinice în displazia articulației coxo-femurale la câine. Teza de doctor în științe medical-veterinare, Chișinău, 2024.

Teza este expusă pe 172 pagini: adnotare, introducere, 4 capitole, concluzii generale și recomandări, bibliografie cu 237 referințe, 8 anexe, 125 pagini text de bază, 21 tabele, 36 figuri. Rezultatele obținute sunt publicate în 11 lucrări științifice.

Cuvinte-cheie: câini, articulația coxo-femurală, displazie de șold, pat vascular, rețea nervoasă, roentgenoscopie, corozia țesuturilor.

Domeniul de studiu: 431.02 – Morfologia, morfopatologia și oncologia animalelor.

Scopul lucrării: studiul morfologic complex al articulației coxo-femurale la câine în normă și stări de displazie de șold.

Obiectivele cercetării: analiza morfometică macromicroscopică a articulației coxo-femurale; evidențierea particularităților de vascularizare a mușchilor cu acțiune asupra articulației șoldului; identificarea surselor de vascularizare a capsulei articulare; precizarea surselor de inervație și distribuție a nervilor în formațiunile articulare și paraarticulare de la nivelul șoldului; stabilirea unghiului Norberg la câinii predispuși la displazie de șold; elaborarea recomandărilor privind utilizarea animalelor de prăsilă în creșterea intensivă a câinilor de rasă.

Noutatea și originalitatea științifică: În premieră, prin metode de injectare a reșinei epoxidice s-au stabilit sursele de vascularizare, arhitectonica patului vascular și incidența variațiilor de distribuție a lor, a fost precizată topografia surselor de inervație și modul de distribuție a nervilor în formațiunile anatomice adiacente articulației coxo-femurale, modalitățile de biodinamică a musculaturii ce acționează asupra articulației coxo-femurale, au fost stabiliți indicii unghiului Norberg la câini de gen, rasă și vârstă diferită.

Rezultate obținute care contribuie la soluționarea unei probleme științifice importante: s-au stabilit caracterul de dezvoltare și stabilizare a componentelor osoase și cartilaginoase ale articulației coxo-femurale; conformația și biomecanica musculaturii regiunii șoldului la câine, variațiile individuale ale surselor de vascularizare, inervație și arhitectonica patului vascular și a rețelei nervoase locale; indicii unghiului Norberg la diferiți câini, care vor contribui la depistarea precoce a predispunerii la displazia de șold.

Semnificația teoretică și valoarea aplicativă a lucrării: rezultatele obținute completează cunoștințele fundamentale despre conformația și biomecanica musculaturii regionale, sursele de vascularizare și inervație, arhitectonica patului vascular și a rețelei nervoase a capsulei articulare și a mușchilor cu acțiune asupra articulației coxo-femurale. Servesc drept suport de orientare în realizarea intervențiilor chirurgicale. Datele obținute vor facilita selecția câinilor pentru reproducere.

Implementarea rezultatelor științifice: în crescătorii de câini de rasă, canise, clinici veterinare și în procesul didactic la disciplinele de profil ale facultății de Medicină Veterinară, UTM.

АННОТАЦИЯ

ДУМИТРИУ Антонина. Анатомо-клинические аспекты дисплазии тазобедренного сустава у собак. Кандидатская диссертация по специальности Ветеринарные науки, Кишинев, 2024.

Диссертация представлена на 172 страницах и включает: аннотация, введение, 4 главы, общие выводы и рекомендации, 237 библиографических источников, 8 приложений, 125 страниц основного текста, 21 таблиц, 36 рисунков. Полученные результаты опубликованы в 11 научных статьях.

Ключевые слова: собаки, тазобедренный сустав, дисплазия тазобедренного сустава, сосудистое русло, нервная сеть, рентгеноскопия, коррозия тканей.

Область исследования: 431.02 - морфология, морфопатология и онкология животных.

Цель работы: комплексное морфологическое исследование тазобедренного сустава у собак в норме и при дисплазии тазобедренного сустава.

Задачи исследования: макромикроскопический морфо-метрический анализ тазобедренного сустава; выделение особенностей васкуляризации мышц, действующих на тазобедренный сустав; определение источников васкуляризации капсулы; уточнение источников иннервации и распределения нервов в суставных и пара-артикулярных образованиях бедра; определение угла Норберга у собак, предрасположенных к дисплазии тазобедренного сустава; составление рекомендаций по разведении породистых собак.

Научная новизна и оригинальность: впервые методом инъекций эпоксидной смолы установлены источники васкуляризации, архитектура сосудистого русла и частота вариаций их распределения, определена топография источников иннервации и распределение нервов в региональных анатомических образованиях, установлены биодинамические режимы работы мышц, воздействующих на тазобедренный сустав, определены показатели угла Норберга.

Получены результаты, способствующие решению важной научной задачи: установлен характер развития и стабилизации костного и хрящевого компонентов тазобедренного сустава; проведено изучение конформации и биомеханики региональной мускулатуры собаки; установлены индивидуальные вариации источников васкуляризации, иннервации и архитектуры сосудистого русла и локальной нервной сети; установлены индексы угла Норберга у разных собак, что будет способствовать раннему выявлению предрасположенности к дисплазии тазобедренного сустава.

Теоретическая значимость и прикладное значение: Полученные в работе результаты дополняют фундаментальные знания о конформации и биомеханике региональных мышц, источниках васкуляризации и иннервации, архитектуре сосудистого русла и нервной сети капсулы тазобедренного сустава и мышц, приводящих его в движение. Разработаны ориентиры необходимые при проведении хирургических вмешательств. Использование разработанного способа раннего выявления предрасположенности к дисплазии тазобедренного сустава позволит отбор для разведения собак свободных от данного синдрома.

Результаты исследования внедрены: в профильных департаментах ТУМ, в породных питомниках и ветеринарных клиниках.

ANNOTATION

DUMITRIU Antonina. Anatomical-clinical aspects in coxofemoral joint dysplasia in dogs. Doctoral thesis in medical-veterinary sciences, Chisinau, 2024.

The thesis is presented on 172 pages and contains: annotation, introduction, 4 chapters, general conclusions and recommendations, bibliography with 237 references, 8 appendices, 125 pages of basic text, 21 tables, 36 figures. The results obtained are published in 11 scientific papers.

Key words: dogs, coxofemoral joint, hip dysplasia, vascular bed, nervous network, roentgenoscopy, tissue corrosion.

Field of study: 431.02 – Animal morphology, morphopathology and oncology.

The purpose of the paper: the complex morphological study of the coxofemoral joint in dogs in normal and hip dysplasia states.

The objectives of the research: morphometric macromicroscopic analysis of the coxofemoral joint; highlighting the particularities of vascularization of the muscles acting on the hip joint; identifying the sources of vascularization of the joint capsule; specifying the sources of innervation and distribution of nerves in the articular and para-articular formations at the hip level; establishing the Norberg angle; development of recommendations regarding the use of breeding animals in the intensive breeding of purebred dogs.

Scientific novelty and originality: for the first time, using epoxy resin injection methods, the sources of vascularization, the architecture of the vascular bed and the incidence of variations in their distribution were established, the topography of the sources of innervation and the distribution of nerves in the anatomical formations adjacent to the coxofemoral joint, the biodynamic modalities of the musculature acting on the coxofemoral joint were specified, the Norberg angle indices in dogs of different gender, breed and age were established.

Obtained results that contribute to the solution of an important scientific problem: the developmental and stabilizing character of the bony and cartilaginous components of the hip joint have been established; the conformation and biomechanics of the regional musculature in the dog, individual variations in the sources of vascularization, innervation and architecture of the vascular bed and local nerve network; Norberg angle indices in different dogs, which will contribute to the early detection of predisposition to hip dysplasia.

Theoretical significance and application value of the work: the results obtained complement the fundamental knowledge of the conformation and biomechanics of the regional muscles, the sources of vascularization and innervation, the architecture of the vascular bed and the nervous network of the joint capsule and the muscles acting on the hip joint. They serve as a guiding support in performing surgical interventions. Only dogs free of hip dysplasia syndrome shall be used for breeding.

Implementation of the scientific results: in breed kennels, veterinary clinics and in the teaching process in the disciplines of the Faculty of Veterinary Medicine, TUM.

DUMITRIU, ANTONINA

ANATOMICAL AND CLINICAL ASPECTS IN CANINE HIP DYSPLASIA

431.02 - ANIMAL MORPHOLOGY, MORPHOPATHOLOGY AND ONCOLOGY

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