3. Moonsun Jeon, Insook Rhee Paeng, Quantitative detection of tetracycline residues in honey by a simple sensitive immunoassay, Journal Analytica Chimica Acta 626, 2008, 180–185;
4. Nuria Pastor-Navarro, Sergi Morais, Angel Maquieira, Rosa Puchades, Synthesis of haptens and development of a sensitive immunoassay for tetracycline residues Application to honey samples, Journal Analytica Chimica Acta, Volume 594, Issue 2, 2 July 2007, Pages 211-218;
5. Hendrik De Ruyck, Herman De Ridder, Determination of tetracycline antibiotics in cow's milk by liquid chromatography/tandem mass spectrometry, Rapid Communications in Mass Spectrometry. 2007; 21: 1511–1520 Published online in Wiley InterScience, DOI: 10.1002/rcm.2991;
6. Alessandra Emilia Savarino, Valentina Terio, Roberta Barrasso, Edmondo Ceci, Sara Panseri, Luca Maria Chiesa, Elisabetta Bonerba, Occurrence of antibiotic residues in Apulian honey: potential risk of environmental pollution by antibiotics, Italian Journal of Food Safety 2020; p.14, 9:8678 doi:10.4081/ ijfs . 2020.8678.

UDC: 636.7:611.835.5

INNERVATION OF THE HIP REGION IN THE DOG

Dumitriu Antonina, PhD student, toniadumitriu@gmail.com
Enciu V., habilitated doctor, university professor, enciu@bk.ru
Didoruc S., PhD student**.** sergiudidoruc@gmail.com

Tehnical University of Moldova

In order to determine the contributions of the nerves and their clinical involvement in the transmission of afferent and efferent nerve impulses, we performed an anatomo-topographic study of the origin and distribution of the nerves participating in the innervation of the canine pelvic limb, especially the coxo-femoral region. The study was performed on three cadavers of crossbred dogs, respectively six coxo-femoral joints. The bodies were taken from different clinics of the city of Chisinau. Pelvic region and hind limbs of cadavers were dissected and fixed in 10% formalin solution.

The research results demonstrate that the canine hip is innervated by the following nerves: femoral nerve, obturator nerve, cranial gluteal nerve, caudal gluteal nerve, caudal femoral cutaneous nerve and sciatic nerve, and the joint capsule is innervated by nerve branches: femoral nerve, obturator nerve , cranial gluteal n. and sciatic n. with their respective cranioventral, caudoventral, craniolateral and dorsolateral directions. The branches of the caudal gluteal nerve were not observed to *be involved in the innervation of the coxofemoral joint capsule. The data obtained provide valuable information to veterinarians to analyze the possibilities of pain reduction and possible surgical interventions in the region of the hip joint.*

Key words: *dog, pelvic limb, innervation.*

Introduction. The coxofemoral joint is a joint with three axes of movement, very important in statics and locomotion [1]. The study of the innervation of the pelvic limb in the dog, especially of the joint of the hip region, is more and more current in the treatment of different conditions that evolve in parallel. Investigations by many authors such as: Kinzel, S., (2002), Schmaedecke, A., (2008), Rocha, L.B., (2013), Elham A. Hassan, (2016) demonstrated that denervation of the joint, by removing the periosteum around of the joint capsule, is one of the "efficient and less traumatic" [6] treatment techniques in coxo-femoral dysplasia, with instant analgesic results, the canine patient gaining freedom of movement [3,4,6,7].

The knowledge of the topography and distribution of the nerve trunks, the morphological and structural interpretation of the sources of innervation are of essential anatomical and clinical interest, as well as therapeutic in the case of dogs with hip dysplasia and arthritis, especially senile ones, with joint dysfunctions accompanied by pain and functional disorders [2].

Over many decades, numerous anatomical investigations have been carried out, in humans and animals, of the structure of the coxo-femoral joints, pain mechanisms in the region and therapeutic approaches. Thus, the somatic origin of the nerves of the joint capsule originating from the autonomic nervous system, the path of the main nerves to the hip joint and a series of pain models were demonstrated and described.

Materials and Methods. Hindlimbs from three cadavers of different large and medium-sized dogs, three right limbs and three left limbs, respectively, dissected in the midline along the lumbar vertebrae, were studied. Prior to dissection, the corpses were preserved in formalin solution. To remove the irritating effects of formalin, these pieces, originally preserved in 10% formalin solution, were placed in repeated baths with a reduced concentration of 5%.

On the pelvic limbs, it was possible to observe that the anatomical pieces presented a satisfactory degree of preservation which was associated with significant changes in texture and color. The color changes were represented by the total loss of the shades characteristic of the fresh preparation and their turning towards shades of gray. The consistency was also altered, with almost complete stiffening of the musculature observed. The anatomical parts thus prepared, although they showed changes in color and consistency, faithfully preserved the regional topography, respectively, the position of the muscles, vessels and nerves.

The sources of innervation of the coxo-femoral joint will be highlighted by macroscopic methods and fine anatomical dissection, according to В.П. Воробьёв, under the control of the binocular magnifier, which will allow following the nerve trunks from the origin to the organ.

Results. Following the dissections, no morphological dysfunctions of the component structures of the pelvic limb were detected and the detailed observations of the adjacent nerves and structures are described as follows.

The innervation sources of the coxo-femoral joint have a somatic character, having origins in the *Plexus lumbalis caudalis* and *Plexus sacralis cranialis*. Together, through numerous connections, they form a powerful lumbosacral plexus.

The caudal lumbar plexus *Plexus lumbalis caudalis* is formed by interweaving the nerve threads of the last three pairs of ventral lumbar branches - L4, L5, L6. The caudal lumbar nerve plexus has connections with the cranial lumbar plexus and the cranial sacral plexus. It presents as distribution branches, the iliomuscular nerve, the femoral nerve and the obturator nerve.

The iliomuscular nerve *N. iliomuscularis* or the proximal muscle branch *Ram. musculares proximales* is detached from L 4 or L 5 and has a very short course, penetrating the psoas muscles. It emits a longer thread that reaches the iliospinal muscle.

The femoral nerve *N. femorales* has two main roots L4 and L5, which have connections with L3 and L6. It is the largest nerve arising from the caudal lumbar plexus and has a predominantly motor component with a terminal distribution in the quadriceps femoris muscle. After its formation from the mentioned roots, the nerve follows a caudo-ventral path, passes between the psoas muscles, then under the iliac fascia and the tailor muscle and reaches the proximal extremity of the quadriceps femoris muscle, where it enters between the rectus femoris muscle and the vastus medialis muscle . In its course, it gives off branches for the muscles: m. iliac, m. sartorius, m. gracilis and a thick branch - the saphenous nerve.

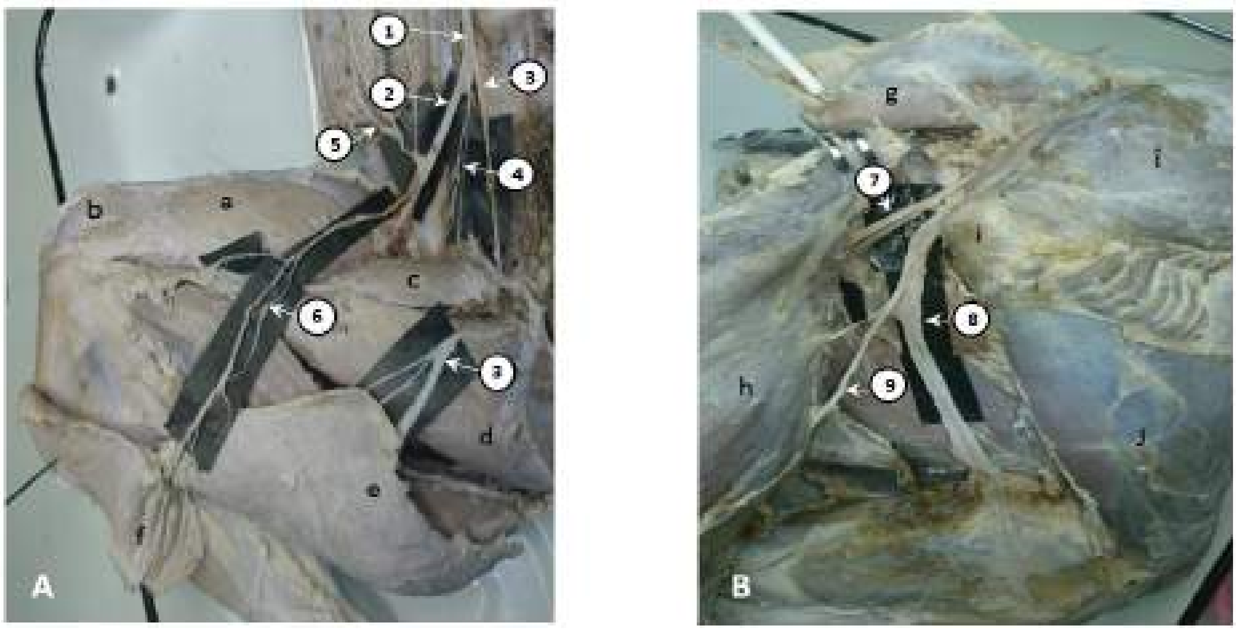

Fig. 1 (A,B) *1- Plexus lumbalis caudalis, 2 - N. femorales, 3 - N. obturatorius, 4 -* nerve branches in depth *mm. iliopsoas, 5* - nerve branches for *m.sartorius, 6* - branches of *n. femorales, 7 - N. gluteus cranialis, 8 - N. ischiaticus,* 9 - nerve branches for *m. tensor fasciae latae, a - m. rectus femoris, b - articulatio genus, c -m. pectineus, d - m. adductor, e - m. gracilis, f - m. sartorius, g - m. gluteus superficialis, h - m. tensor fasciae latae, i - trochanter major, î - m. gluteus medius, j - m. vastus medialis.*

The saphenous nerve *N. saphenus*, separates from the femoral nerve, under the sartorius muscle. It has a descending course between the sartorius muscle and the vastus medialis, crossing the femoral artery. It then emerges, from the depth, either through the mass of the sartorius muscle or through the space between the sartorius muscles and the gracilis muscle and becomes subcutaneous. At this level, it branches through several threads, which accompany the saphenous artery and vein, distributing on the medial side of the calf.

The obturator nerve *N. obturatorius* originates in the ventral roots L4, L5 and L6. It is thinner than the femoral nerve. It has a subperitoneal path, at the anterior edge of the semi-pennate portion of the internal obturator muscle, then it goes towards the obturator hole, through which it leaves the pelvic cavity, along with the homonymous artery and vein. Reaching the medial side of the thigh, it is distributed in the pectineus and gracilis muscles. In its course it gives off branches for the obturator muscles.

The cranial sacral plexus *Plexus sacralis cranialis* is born by joining the roots from the first two or three ventral sacral branches S1 and S2, to which are added the threads from the last lumbar nerve. These, together with S1 and S2, form a fabric located on the ventral side of the sacrospinotuberos ligament. From the fiber exchange of the plexus, a flattened nerve cord results, called the lumbosacral trunk Trunchus lombosacralis. It has a ventro-lateral course towards the ischial foramen, through which it leaves the pelvic cavity.

The lumbosacral trunk branches at the level of the greater sciatic foramen and gives rise to the cranial gluteal nerve, the caudal gluteal nerve, the caudal femoral cutaneous nerve, and the sciatic nerve.

The cranial gluteal nerve *N. gluteus cranialis* originates from its own fibers, in the branches of the connection with the last lumbar nerve and the first sacral nerve. After detaching from the lumbosacral trunk, it is located in the dorso-cranial part of the sciatic hole, where it is a satellite of the cranial gluteal a. After a short journey, the nerve is distributed through 4 branches, in the gluteal muscles - middle, accessory, deep, and in the upper portion of the superficial gluteal muscle. It emits a longer branch that crosses the neck of the ilium, after which it passes, either between the gluteus medius and accessory gluteus muscles, or through the thickness of the accessory gluteus muscle, to reach the tensor muscle of the fascia lata, in whose fleshy portion it is terminally distributed.

The caudal gluteal nerve *N. gluteus caudalis* detaches from the cranial sacral plexus, under the appearance of one or two roots, which exit together with the sciatic nerve, through the ventro-caudal segment of the large sciatic foramen - opposite the cranial gluteal nerve. From the level of the large sciatic foramen, the caudal gluteal nerve follows a path on the dorsal side of the sacrospinotuberous ligament, covered by the deep side of the gluteus medius muscle. At this level it bifurcates terminally, into an upper and a lower branch.

The caudal femoral cutaneous nerve *N. cutaneus femoris caudalis* also detaches from the caudal edge of the plexus, ventral to the origin of the previous nerve. After its detachment from the plexus, at which level various and multiple connections are made, with the sciatic, rectal nerves and follows the dorso-lateral face of the sacrospino-tuberous ligament, towards the ischial tuberosity. It then passes, under the proximal extremity of the biceps femoris muscle, between it and the semitendinosus muscle, reaches subcutaneously and branches in the caudal region of the thigh and croup.

The sciatic nerve *N. ischiaticus*, is the thickest nerve detached from the lumbo-sacral trunk. Through its terminal ramifications, it travels along the entire length of the pelvic limb, reaching the phalanx region. The sciatic nerve detaches from the caudal portion of the lumbo-sacral plexus, under the appearance of a thick and flattened cord, exits the pelvic cavity at the level of the large sciatic foramen and passes on the dorsal side of the sacrospinotuberos ligament, under the middle gluteal muscle. At this level, it presents the connection with the pudendal and rectal nerves, thus resulting in a sciatic plexus, from which the caudal femoral cutaneous nerve is isolated. It passes over the supraacetabular ridge, recurves ventrally, caudally by the coxofemoral joint, at which level it bifurcates terminally into the tibial nerve and the fibular nerve.

In its course, the sciatic nerve gives off the following branches:

The articular branches separate from the sciatic nerve, either in the form of a bundle or in the form of a thin thread. Regardless of the aspect, the muscle branches cross the deep gluteal muscle, proximal to the coxofemoral joint, pass over the supraacetabular ridge and are distributed in the capsule hip joint.

The muscle branches are represented by:

- a fine branch, for the deep gluteal muscle;

- branch for the twin muscles of the pelvis, detached together with

- the branch for the square femoral muscle;

- branch for the propulsive muscles - the small sciatic nerve, which can be considered as a completely separate nerve, separated from the lumbosacral plexus, which only accompanies the large sciatic nerve, up to the caudal face of the coxo-femoral joint. After separating from the large sciatic nerve, the small sciatic nerve bifurcates after a short course and gives:

- a cranial bundle, for the femoral biceps muscle;

- two caudal bundles, for the semitendinosus muscle and for the semimembranosus muscle.

References

1. DUMITRIU, A., ENCIU V., Muscle groups that ensure the dynamics of the hip joint in dogs. International Scientific-Practical Conference „Біобезпека, захист та благополуччя тварин.", Kiev, 2021, p. 80-82, УДК 591.555.3 (082). Available: https://nmc-vfpo.com/mizhnarodnu-naukovo-praktychnu-konferencziyu-biobezpeka-zahyst-ta-blagopoluchchya-tvaryn/

2. DUMITRIU, A. Hip dysplasia in dogs. International scientific materials Conference dedicated to the 75th anniversary of the establishment of the Nicolae Testemitanu State University of Medicine and Pharmacy of the Republic of Moldova, Chisinau, 2020, 44-47, ISBN 978-9975-57-281-1. Available: https://repository.usmf.md/handle/20.500.12710/13623

3. HASSAN, E.A., LAMBRECHTS, N.E., WENG, H.Y., SNYDER, P.W., BREUR, G.J. Effects of denervation of the hip joint on results of clinical observations and instrumented gait analysis in dogs with sodium urate crystal-induced synovitis. Am. J. Vet., Res. 2016; 77(11):1200-1210. doi: 10.2460/ajvr.77.11.1200. Available: https://pubmed.ncbi.nlm.nih.gov/27805445/

4. KINZEL, S., C. VON SCHEVEN, A. BUECKER, T. STOPINSKI, AND W. KUPPER. Clinical evaluation of denervation of the canine hip joint capsule: a retrospective study of 117 dogs. Vet. Comp. Orthop. Traumatol.2002; 15, 51–56. Available: https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0038-1632713

5. NOMINA ANATOMICA VETERINARIA, 6th ed. Published by the Editorial Committee Hanover (Germany), Ghent (Belgium), Columbia, MO (U.S.A.), Rio de Janeiro (Brazil), 2017. [September-december 2022]. Disponibil: https://www.wava-amav.org/wava-documents.html.

6. ROCHA, L.B., Denervação articular coxofemoral em cães com doença articular degenerativa secundária à dysplasia, Ci.Anim.Bras, 2013.v.14, n.1, p120-134. doi: 10.5216/cab.v14i1. Available: https://www.scielo.br/j/cab/a/X6HJgmy3kY7Qv9Pqsc38TFf/?lang=pt&format=pdf

7. SCHMACDECKE, A, FERRIGNO, CRA. Anatomic comparison of the innervation of hip joint in human and dogs. Arch. Vet. Sci. 2008; 3:223-228. doi: 10.3415/VCOT-07-10-0098 Available: https://www.thieme-connect.com/products/ejournals/abstract/10.3415/VCOT-07-10-0098