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The Importance of Ultrasonography in the Exploration of the Superficial Lymphatic System of Carnivores

Florin STAN [1], Aurel DAMIAN [1], Ionel PAPUC [2], Alexandru GUDEA [1], Ioana CHIRILEAN[1], Cristian DEZDROBITU[1], Ileana BOCHIŞ, Melania CRIŞAN[1], Abu Rock AYMAN, Irina IRIMESCU, Flaviu TUNS[1]

[1] Department of Comparative Anatomy, [2] Department of Semiology, Ethology and Imaging Diagnostic, University of Agricultural Sciences and Veterinary Medicine, Cluj Napoca, Faculty of Veterinary Medicine Cluj-Napoca, 3-5, Mănăștur Street, 400372, Romania
flodvm@yahoo.com;

Abstract. The present study conducts on the basis of a topographical and anatomical systematization a characterization in terms of imaging of the superficial lymph nodes. Starting from the topographic anatomy of the superficial lymph nodes at carnivores, suitable for the tactile method of investigation, this study standardizes the imaging aspects of superficial lymph nodes, more specifically, their ultrasound anatomy. 7 female dogs of different breeds and ages, clinically healthy were assessed by ultrasound. Methods of investigation: two-dimensional ultrasound and in addition to this, color Doppler and power Doppler techniques. Ultrasound techniques were applied to 34 axillary, superficial inguinal and polipteus lymph nodes using an advanced ultrasound machine, equipped with "small parts mode". Two-dimensional ultrasound images were obtained to quantify data on topography, size, shape, capsule node, ecostructure and echogenicity. Doppler techniques have revealed the presence and the characteristics of lymph circulation. The results obtained show that lymph nodes are essential structures which have to be assessed at any ultrasonographic examination, among other parenchymal organs. The most useful parameters for characterization are: the transverse with the longitudinal axis ratio, with a value below 0.5 indicating oval shape of examined lymph nodes and the ordered model, the radial distribution of the capsule toward the hilum of the blood vascularization.

Keywords: lymph nodes, topography, ultrasound, Doppler ultrasound anatomy.

INTRODUCTION

The lymphatic system of carnivores is an area less studied and explored, in terms of imaging, until now. Ultrasound is a medical investigation method that uses the fabric-backed ultrasound physical carrier of information (1.2). Among the non-invasive methods of investigation of the lymphatic system, ultrasound should be assigned a distinctive role. It is true that without knowing anatomy and topography of this system is practically impossible to carry out an investigation which is to be completed with response to various types of aggression. Lymph nodes in general and in particular those of carnivores, are difficult to approach and view ultrasonographic, requiring better examining conditions and an advanced (3). On the other hand, the examiner must possess thorough anatomic knowledge of the examined sectioned area, topography and anatomical projection of the structure concerned. The vast majority of lymph nodes are small, difficult to identify by ultrasound, but what is really an impediment is their echogenicity very close to that of neighboring tissues, especially in the absence of a pathological process to change the lymph node architecture.

Furthermore, the arrangement or lymph nodes in the intermuscular or connective spaces makes the acoustic impedance difference to be low and therefore the reflection will be weak and the interfaces less echogenic. Another difficulty is experienced in evaluating the lymph nodes in the abdominal cavity due to gas interposition in the gastrointestinal nerves, air being a bad conductor of ultrasound, forming a screen in the way of their absorption. The lymph nodes impressed by a bone structure are also impossible to be ultrasonographicaly evaluated due to a very dense bone environment which greatly attenuates the ultrasound beam, as an insurmountable obstacle. For the lymph nodes located deep, the ultrasonographic approach is hampered by the overlaid tissues, the quality of the transmitted image being also affected. The exploration of a structure located deep requires long time of response for each ultrasonic pulse.

In veterinary medicine, the quality of care is based on a correct diagnosis which can only be achieved through a continuous specialization. The last years of research reveal more than ever the interdependence of theoretical knowledge with their practical application.

MATERIALS AND METHODS

34 lymph nodes belonging to 7 female dogs, superficial inguinal left and right lymph nodes and popliteus left and right lymph nodes were ultrasonographicaly evaluated (total of 28 lymph nodes). In addition, the left and right axillary proper and accessories lymph nodes were examined in 3 subjects (6 lymph nodes). Two-dimensional ultrasonography and Doppler ultrasound techniques, was achieved with a Toshiba Medical System device, provided with "small parts mode". The transducer used had a frequency of 7.5 MHz and was tailored (in the location of deep or superficial lymph nodes), and purpose. Prior to imaging investigation, lymph nodes were palpated through the skin and the subcutaneous tissue, to identify the place of the ultrasound approach, which often corresponded to the anatomical projection of lymph nodes. For the axillary lymph nodes, the palpation was performed after the chest member was moved forward. The subjects' preparation consisted of trimming and shaving a small portion of fur located near the axillary, inguinal and politeus area. The ultrasonographic approach was performed ventral (above) for axillary and superficial inguinal lymph nodes and posterior for popliteus lymph nodes. Axillary lymph nodes were examined in longitudinal section, the superficial inguinal and popliteus in sections both longitudinal and cross. At a further two-dimensional examination, by highlighting the area of interest on the anatomical image, by surrounding the lymph and applying the Doppler effect, we followed the movement of lymph node characteristics by color Doppler and power Doppler techniques.

RESULTS AND DISCUSSIONS

The two-dimensional ultrasound evaluation criteria that we follow cover the following aspects: size, shape, parenchyma echogenicity, hilum ecostructure and the appearance of lymph node capsule. The lymph nodes dimensions were evaluated by measuring the two axes: transversal and longitudinal. The transversal axis of axillary lymph nodes had values between 0.5 and 1 cm longitudinal-values ranging from 1.4 to 2.5 cm. Accessory axillary lymph nodes had values from 0.2 to 0.9 cm of the transversal axis and 0.7 to 1.5 cm. of the longitudinal axis. Superficial inguinal lymph nodes were ultrasonographicaly detected as a package consisting mostly of two or three lymph nodes with varying sizes ranging from 0.8 to 1.9 cm transversal axis and 2.1 to 4.8 cm longitudinal axis. The values of the transverse axis of the lymph nodes popliteus were 0.4-1cm, the longitudinal axis of 2 to 2.6 cm, and they grouped in

two or three. The lymph nodes assessed had an elongated, oval shape, including those grouped under a common capsule. The transverse axis / longitudinal axis report was at all

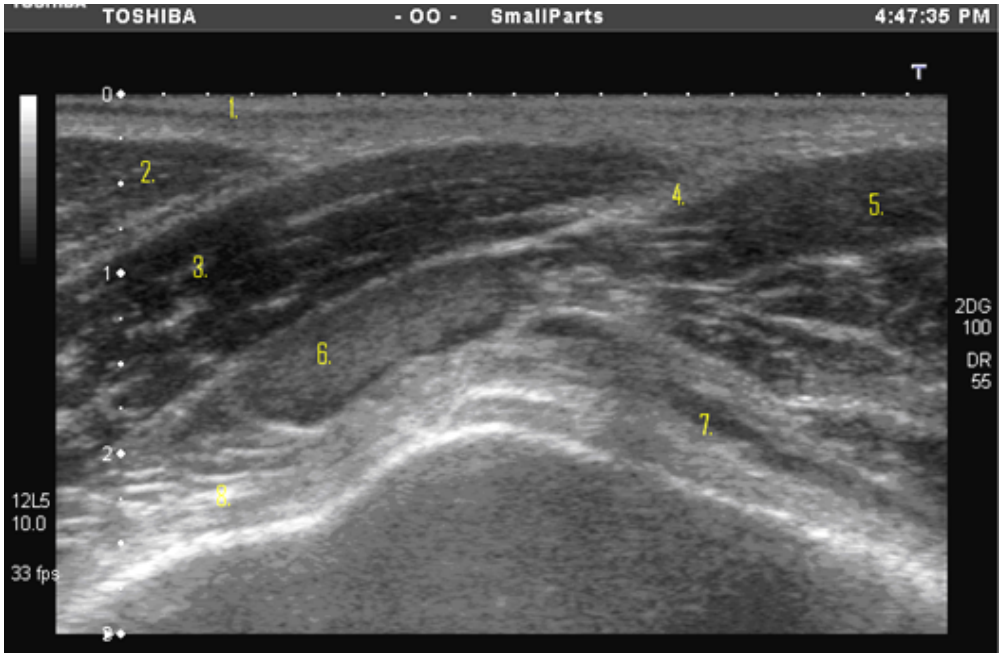

Fig.1. Two-dimensional ultrasonographic appearance and topography of a popliteus lymph node

measurements below 0.5, which confirms the oval appearance, without rounding tendencies.

1. the surface plan, represented by the skin and subcutaneous tissues. The tegument appears as a hypercogeneous line, represented by the interface between gel and skin. The subcutaneous tissue consisting of a low fat layer represented in this picture, has a fine hypocogenuos structure with fine hypercogenuous septa composed of connective tissue;
2. the semitendinosus muscle, the distal portion with a hypoecogenous character;
3. femoral biceps muscle in longitudinal section which hypoecogenous muscular highlights, separated by hyperecogenous fibroadipoase structures;
4. conjunctive sept;
5. the gastrocnemius muscles, in the area proximal to the insertion;
6. popliteus lymph node,
7. caudal femoral artery;
8. proximal insertions of gastrocnemius muscles;

Regarding the echogenicity of the parenchymal lymph node, it was slightly hypoecogenous, compared to the surrounding connective tissues, especially for superficial inguinal lymph nodes which are surrounded by fat, with different echogenicity from lymph nodes. The ultrasonographical structure of the parenchymal lymph node was homogeneous in all lymph nodes examined. The echogenicity of the hilum was a common feature of lymph nodes. The capsule appeared to be continuous both in single lymph nodes and in the grouped ones, bounding well to adjacent structures. From the 14 superficial inguinal lymph nodes examined, 5 specimens had a composite part, consisting of 3 lymph nodes, and 2 showed 2 lymph nodes. The blood supply, measured by color Doppler and power Doppler technique,

was identified from the hilum level in most lymph nodes. An exception of four small accessory axillary lymph nodes appeared to be avascular on color Doppler technique, but power Doppler method certified vascular signal in two of them.

Knowing the anatomical peculiarities of the superficial lymphatic drainage, (4, 5), is essential for medical examiner in the ultrasonographic evaluation of inflammatory diseases or tumors. It is known that the metastasis in majority of the tumors is done by nodes (6, 7), lymph nodes are the first structures that can be ultrasonographicaly identified as amended. The normal, elliptical shape of the axillary, superficial inguinal and popliteus lymph nodes, confirmed by ultrasound, is given by the lymph node capsule and the trabeculae, with a similar capsule structure, extended from this cortical area, until the bone marrow (8). This

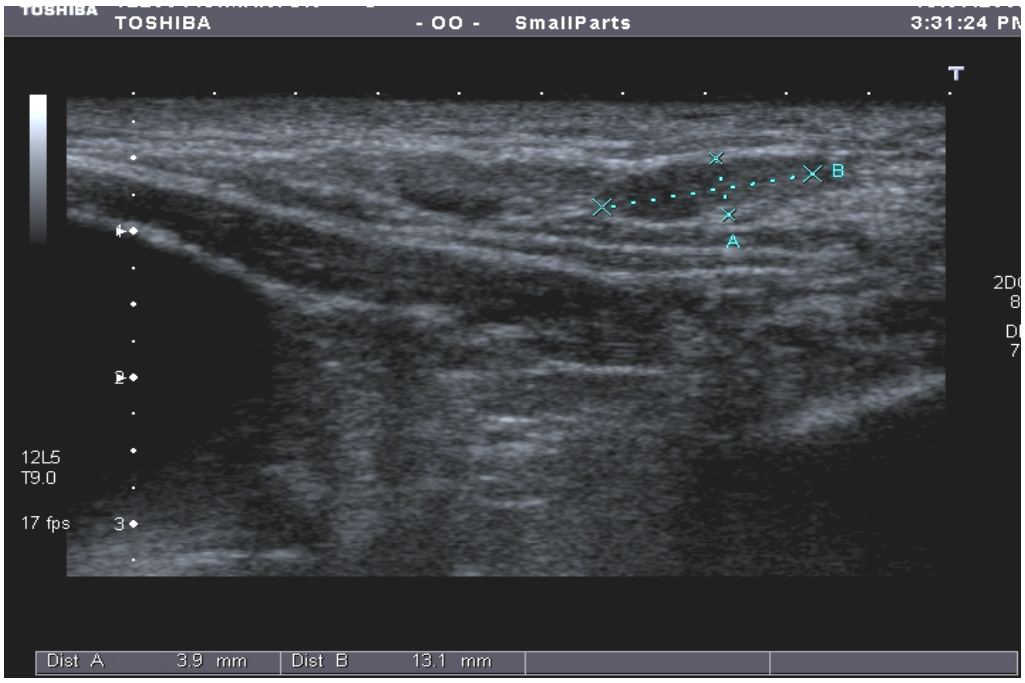

Fig. 2. The measurement of axillary lymph node size in evaluating its perpendicular axis (transversal-A and longitudinal-B).

network, consisting of the capsule and the trabeculae, actually maintain the elongated shape of lymph.

Regarding the sizes, they are variable, depending on the race and definitely to the act of belonging to a certain lymph centrum and moreover, according to the drained territory (14). Thus, we ultrasonographicaly noted the greater dimensions of superficial inguinal lymph nodes and popliteus - the longitudinal axis 2.6 cm and 4.8 cm, compared to axillary lymph nodes - 2.5 cm longitudinal axis, the size being reduced in axillary accessories lymph nodes, averaging 1 cm, which were identified in three specimens. This is due to the small size, non identifiable by ultrasonography on one hand, and on the other hand, to their absence, (5) in the lymphatic drainage in some copies, remark noted by other authors as well (9). The vast majority of lymph nodes have an echogenicity very close to the surrounding tissues, making them difficult identifiable by ultrasound (1, 3). The ecogenicity of axillary lymph nodes was similar to that of the large round muscle, namely, its distal portion and of those accessories, with ascending pectoral muscle and the big back muscle, which lies between. The platysma muscle appears as a thin band, hypoecogenous separated by thin connective hyperecogenous

septa. The same characterization applies to poplitei lymph nodes, related to its echogenicity similar to the biceps femoris, the gastrocnemian and the semitendinous muscle. Closely following the ultrasonographic aspect at the level of the hilum, I noticed at all lymph nodes examined, its echogenicity. The hilum's echogenicity is due to the multiple medullary sinuses converging towards the hilum. Each of them represents an acoustic interface, which partly reflects the ultrasound, thus participating in obtaining the picture. In addition, the fat infiltration of the hilum, makes this aspect even more obvious (2, 10) as a linear structure, easy hyperecogenous, which continues with the surrounding fat tissue. In 2 old subject of our study, due to the more significant body fat, this aspect was more visible, especially in the examination of superficial inguinal land popliteus lymph nodes, which had larger sizes. We can not however make remarks on the hilum's ecogenicity in accessories axillary lymph nodes, which most had less than 0.8 cm in average size. The capsule of the examined lymph nodes appeared to be continuous, slightly hyperecogenous, delimiting well the lymph nodes. What makes the capsule visible is slight difference of acoustic impedance between lymph nodes and adjacent tissues, especially when they are represented by adipose tissue (3, 11).

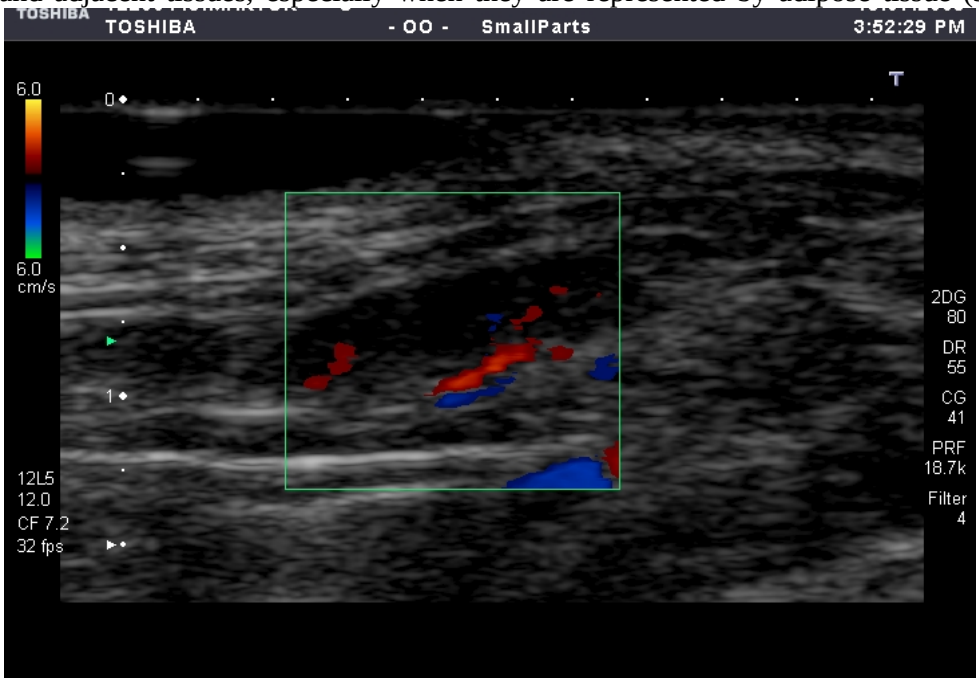

Fig.3. Assessing the direction and velocity of blood flow in superficial lymph nodes by color Doppler technique

This particularly concerns the superficial inguinal lymph nodes, located at lateral edge of the last teat, embedded in a rich fat mass (12), or in certain subjects, with well represented fat tissue.

Regarding lymph node vascularization, assessed by Doppler techniques, and considering another study of our previously made (13), we could described the vascular angioarchitecture. Color Doppler showed in the axillary, superficial inguinal and popliteus bigger than 0.6 cm the blood flow in the hilum, which distributes the lymph node parenchyma through fine vessels, relatively thin and not very numerous, with an uninterrupted appearance, radially from the hilar vessels. The direction given by the presence of colors - red for blood flow as it approaches the transducer, and blue for the one that is removed (1, 3), is towards the lymph nodes and also from them. There is no correlation between type of arterial or venous

blood flow and the colors red or blue. The speed of the blood flow, revealed by a deeper shade of the colors was raised to the hilum and as it departs from it, the shades were less intense and showed a lower speed. If the case of 4 accessories axillary lymph nodes, ranging in size from 0.3 to 0.6 cm, Doppler technique did not reveal blood flow, the lymph nodes seeming to be avascular.

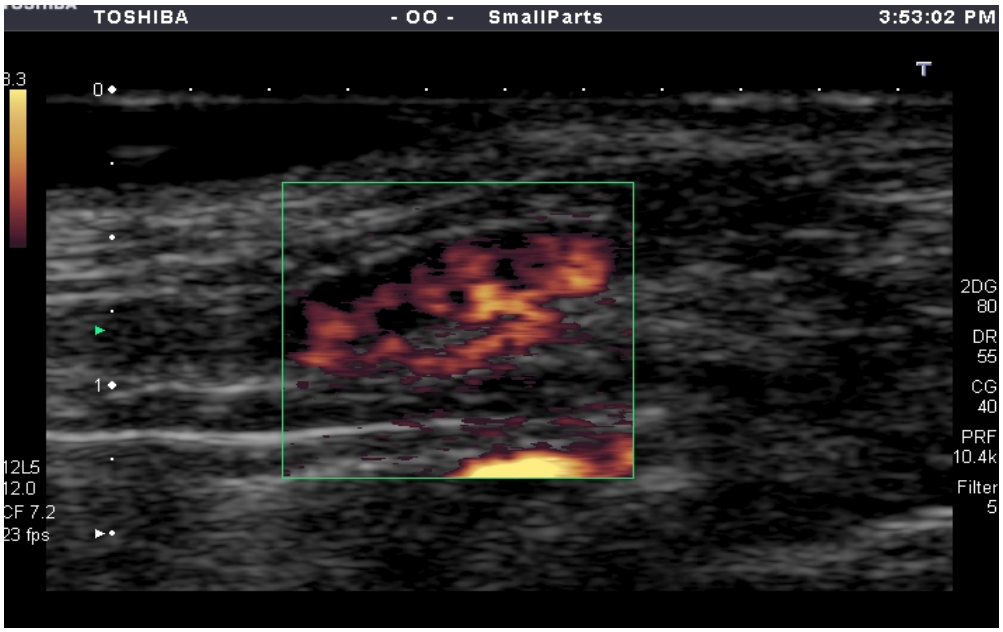

Fig. 4. Ultrasonographic evaluation of superficial lymph nodes vascularization by power Doppler method

Examination in the power module, capable of detecting vascular signals in small vessels, detected vascular signal in most lymph nodes examined except for two very small lymph nodes (0.3 / 0.5 cm), axillary belonging. The monochrome information obtained from power Doppler exploration certifies again the presence and characteristics of blood flow in superficial lymph nodes associated to lymphatic drainage.

Lymphatic pathology may be independent or secondary to many diseases. The lymph nodes are discovered by chance many of the times, shifting the perspective of a diagnostic classification. Increasing the volume of lymph nodes may occur as a reaction to antigenic stimulation in response to infectious (bacterial, viral, parasitic, fungal), infectious (chemicals, drugs), their antigens (for autoimmune diseases) or neoplastic infiltration (lymphoma, metastases.) All these changes can be recognized through ultrasonography. The suspicion of pathologic lymph node disease arises when the two-dimensional ultrasound changes are noted in terms of size, related to race and have sharp changes in shape, contour, ecostructure and echogenicity. These changes are well defined by ultrasonography as to obtain detailed images in multiple anatomical sections. Color Doppler and power Doppler techniques applied to lymph nodes are able to differentiate normal from pathological angioarchitecture, both in terms of vascular distribution and their characteristics.

CONCLUSIONS

1. Ultrasonography is an imaging, direct, quick, non-invasive method which can be used in the characterization of superficial lymph nodes.

2. The ultrasonographic anatomy of the superficial lymph nodes include: their topography, their two-dimensional exploration and their vascular evaluation by Doppler techniques.
3. The characteristics of bi-dimensional ultrasonography in normal lymph nodes are: elongated, transversal axis/longitudinal axis ratio less than 0.5, the continuous capsule, the echogenic hilum and the homogeneous structure of the parenchyma lymph node.
4. Exploration using Doppler techniques identifies the ordered vascular pattern from the hilum towards the parenchyma.
5. In lymph nodes smaller than 0.5 cm one can not make judgments on vascularity using the Doppler techniques.

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