

Power Doppler Ultrasonography vs Color Doppler of the Sentinel Lymph Mammary Glands at Female Dog

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Abstract. The DOPLER ultrasonography is a relatively new technique in exploring the lymphatic system. Doppler ultrasonography is a further technique of ultrasound investigation applicable especially to vascular structures and also to the blood flow from these structures. As an independent technique it is used particularly in assessing the superficial or deep arteries and veins (abdominal, pelvic), except in evaluating the intracranial segments of internal carotid arteries, where magnetic resonance or angiography is sovereign. Doppler examination method complements two-dimensional ultrasonography applied to organs and parenchyma structures. The objective pursued by the Doppler technique, related to the lymph nodes is represented by the blood flow of lymph vessels. Doppler obtained data refer to: the presence, direction, speed and character of the blood flow that contributes to generating the Doppler signal. The aim of the study is to compare the two methods which use Doppler effect, color Doppler and power Doppler in assessing vascular architectonics of sentinel lymph nodes of mammary glands and to determine the method with the highest sensitivity to identify lymph vessels. 38 lymph nodes belonging to 18 bitches, of which 14 were presenting pathology and 4 subjects showed no associated pathology were examined using ultrasound. 18 metastatic lymph nodes were identified, which revealed impaired vascular architectonics, 12 lymph nodes with inflammatory increased vascular signal and 6 normal. At 2 lymph nodes the presence of vascular signal was not observed. The Power Doppler method identified more accurately the vascular signal compared to the Color Doppler ultrasound.

Keywords: Ultrasonography, Doppler, lymph nodes, bitch, lymphatic system.

INTRODUCTION

Ultrasound imaging is the first method of investigation used in the presence of a lymphadenopathy. In this context, it can be considered an extension of the clinical examination if possessing a complete knowledge of topographic anatomy and pathology of the lymphatic system (1, 13, 16). Ultrasonography is the imaging method mostly used nowadays to identify the non-invasive sentinel lymph nodes. Combining Doppler examination techniques with two-dimensional method raises the degree of sensitivity and specificity in detecting sentinel lymph nodes. Inflammatory disorders but also the systemic ones frequently evolve into adenopathys. Involvement of lymph nodes may be of inflammatory or neoplastic nature, and therefore identifying sentinel lymph nodes is particularly important to establish the diagnosis and treatment. The presence or absence of lymph node metastases has an big impact in disease prognosis (11). The ultrasonography of lymph nodes is done in two phases: two-dimensional ultrasound, which quantifies the data on the topography, the shape, the size, the echogenicity and the ecostructure of lymph nodes (8) and the Doppler methods (19). Doppler ultrasonography is an additional method of investigation and research of the vascular lymph nodal structures. Color Doppler ultrasonography is a combination of the blood flow

detection on a two-dimensional image in real time (5). One can thus obtain dynamic, functional images, image-oriented and integrated on structural and anatomical characteristics of blood flow: direction, speed, amplitude. Direction is given by the presence of two primary colors, red and blue, red being assigned to conventional blood flow as it approaches the transducer and blue as the blood flowing away from it. The speed is given by color shades, a bright shade meaning high speed and a darker shade, a reduced speed. Power Doppler method shows only the presence of blood flow to the lymph nodes with the advantage of highlighting the vascular signal in small, winding and slow flowing vessels characteristic to these structures, the information entered being monochrome (10).

MATERIALS AND METHODS

The study was represented by 18 female dogs with different pathologies or without associated diseases, of which 38 lymph nodes were assessed by ultrasonography. A total of 6 female dogs showed inflammatory diseases, 8 showed tumor pathology and 4 had no associated diseases, which were later on considered control group. Doppler ultrasonography followed two-dimensional exploration, in which were found changes of shape, size, shape and echogenicity. The examination was performed with a Toshiba Medical System equipment, the program used being "small parts mode" and a frequency of 7.5 MHz of the transducer. The equipment settings were the same in all stages of the examination.

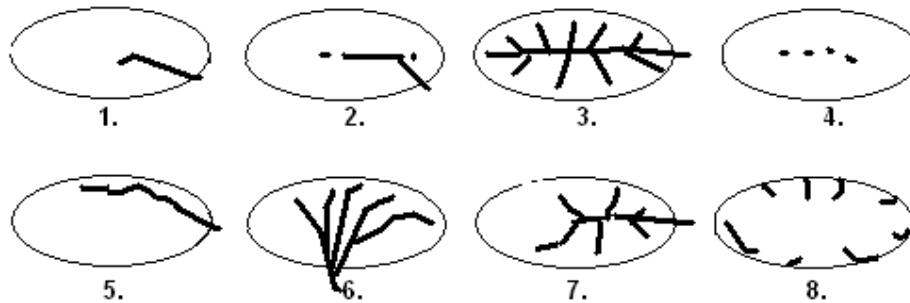


Fig. 1 - Normal (1-4) and pathologic (5-8) angioarchitecture of the lymph nodes.

The criteria for comparison of two ultrasonographic Doppler methods related to pathology and to the group were: the presence or absence of vascular signal, its characterization and membership of a particular pathology, set on the initial two-dimensional assessment of lymph nodes. The absence of the vascular intra lymph nodal signal was defined as a sign of normality, even in the presence of a disease, being recognized as benign (9). Instead, the identification of at least one pathologic pattern of lymph node perfusion, in order to amend and rearrange vascular architectonics was classed as malignant (13). Using the two methods, power and color Doppler we defined quantitative differences (vascular signal on a larger or smaller area) and qualitative (altered vs. normal aspect) of blood flow in the lymph nodes. In describing the angioarchitecture of the lymph nodes we used the evaluation criteria as in the vascular patterns shown in Fig.1.

As shown, the distribution of vessels takes several aspects. 1 hilar vessel which crosses the lymph node, moving along the lymph nodal capsule; 2 longitudinal vessel parallel with the long axis of the lymph node or to the skin surface; 3 peripheral branches which arise from the longitudinal vessels; 4 short segments of the central hilar vessels; 5 space replacement given by a neoplastic process, with vessels pushed to the periphery of the lymph vessel; 6 aberrant angioarchitecture, with one or more central vessels, which do not originate

from the longitudinal vessels; 7 avascular area inside the lymph node which lacks the vascular signal, with intensified vascularisation in the remaining structure; 8 subcapsular distribution of vessels that have not originated in hilar or longitudinal vessels. The accuracy of Doppler ultrasound methods are fully consistent with a previous prospective study taken by our team (17).

The ecographical approach was different, at the axillary region before pulling the front member for axillary lymph center, in the groin area, the last caudal mammary gland for superficial inguinal lymph nodes and a posterior approach to the popliteal fossa for the poplitei lymph.

RESULTS AND DISCUSSIONS

14 axillary lymph nodes, 18 superficial inguinal lymph nodes 18 and 6 lymph poplitei were assessed by ultrasound. Lymphatic drainage of the lymph nodes was performed from the cranial thoracic mammary gland level (T1) and caudal level (T2) for axillary lymph nodes, the superficial inguinal lymph nodes from the caudal abdominal mammary glands (A2) and inguinal mammary glands. Poplitei lymph nodes were evaluated by ultrasound because of the easy approach on the one hand, and on the other hand, according to researchers, their involvement in drainage of caudal mammary glands (12). We can consider certain their involvement in the pelvic inflammatory disease of the limb associated with inflammatory or septic pathology of the caudal mammary glands (17).

The average size of the longitudinal axis was 18.5 mm (range 7-39 mm) and 8.8 mm of the short axis lymph nodes (range 3-17 mm). The ecostructura was homogenous in 22 lymph nodes and heterogeneous in 16 lymph nodes. The color Doppler ultrasonography has classified a number of 18 lymph nodes as malignant (10 from the axillary lymph nodes and 8 superficial inguinal ones), 12 with inflammatory blood flow and 6 with normal vascular architecture. In 3 lymph nodes (two axillary and one belonging to superficial inguinal lymph node), which amounted the suspicion of neoplastic infiltration in gray scale, color Doppler method revealed no vascular signal, but power evaluation module has revealed the presence of vessels with aberrant subcapsular disposition.

In hypervascularised lymph nodes we can not say that there is a considerable advantage of the power Doppler method, the accuracy of both methods are practically equal. The subjects with no associated pathology (the control group) also received ultrasonographic assessment of superficial inguinal lymph nodes and of poplitei by both methods, worth mentioning that at the two poplitei lymph nodes explored color Doppler technique revealed no vascular signal, but power Doppler ultrasound proved its presence and lack of modification.

In no case of our study, color Doppler ultrasound revealed no pathological images that were later on not present at exploring the power module.

Combining the two methods, I made the comparison and classification of the models evaluated as following: normal lymph nodes, inflammation and cancer. Normal lymph nodes have an oval shape, with the ratio of transverse and longitudinal axis of $\frac{1}{2}$ or more (3), clearly demarcated by a continuous capsule with homogeneous echo structure and echogenic lymph nodal hil, corresponding to arterial and venous vessels and sheath support fibro conjunctive (7, 14).

Color Doppler examination showed blood flow from hil towards the periphery, through the ordered vessels, relatively thin and not very many, except two lymph node poplitei which appeared to be a vascular. Power Doppler confirmed the blood flow, including in the two lymph node poplitei without changes, in which the vascular color Doppler signal was lacking.

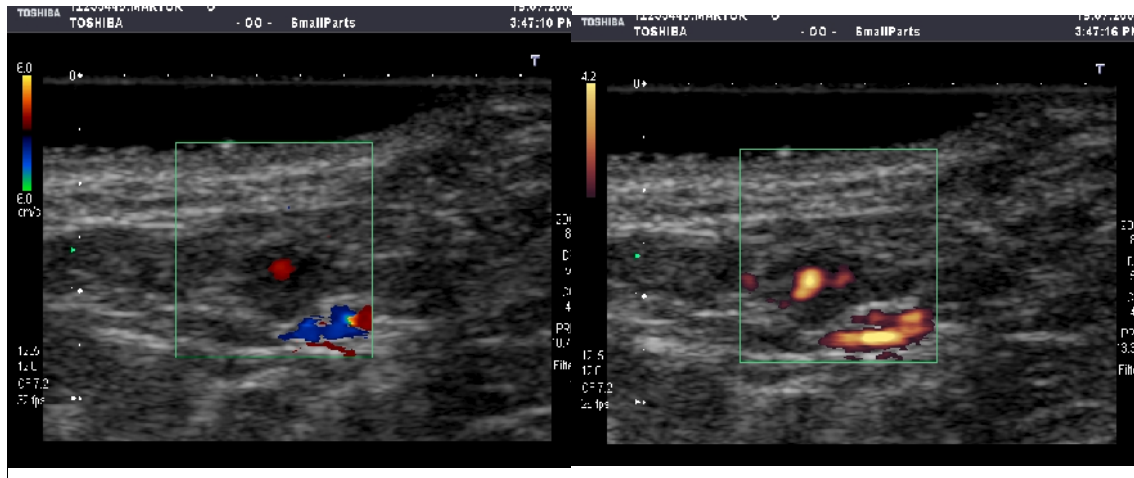


Fig.2 Doppler color image of axillary lymph nodes

Fig.3 Power Doppler image of axillary lymph nodes

The inflammatory lymph nodes identified (4 poplitei and 8 superficial inguinal lymph nodes) were presented moderately increased in volume, but the maintenance of the oval shape was noticeable, appearance also mentioned by other investigators, and the discrete parenchyma hypoechogenicity, neatly divided with intense hil. Inflammatory lymph nodes increasing in size with the maintenance of their oval shape is performed on lymph reticular cell activation, specific to an inflammatory process (6, 9). The intra lymph nodal circulation emphasized in the hilum and at the center of lymph nodes is given by the induced vasodilatation by the inflammatory phenomena (3 subjects showed mastitis, 2 showed abscesses and a single one showed a bruise of the mammal). Highlighting the vascular signal in the center of lymph node can exclude a metastatic neoplastic disease (2).

Metastatic lymph nodes belonging to the axillary lymph nodes-7 axillary lymph nodes and 3 adjacent - and 8 accessories superficial inguinal lymph nodes, had a rounded form, heterogeneous aspect of the parenchyma, irregular edges and hilum heads, slender, small with reduced echogenicity. An important indicator of metastatic lymph nodes is their form (2, 9, 11).

The concept is based on the assumption that metastatic lymph nodes tend to appear more rounded or spherical due to proliferation of malignant cells (11, 13) leading to alterations in shape. The relationship between the longitudinal and the transversal axis of metastatic lymph nodes was less than 2, value confirmed in other studies on human models (18, 20). The ecostructure is less specific because metastatic lymph nodes may appear to be well circumscribed and sometimes homogeneous, characteristic of benign lymph nodes (3). In the well breed subjects there can sometimes appear a substitution of space given by adipose conglomeration which can show images easily confused with those affected by cancer invasion. In this context it is imperative to assess the blood flow. Doppler methods have shown altered angioarchitecture with exacerbation of peripheral color signal in the parenchyma. Overall, the dominant is the model of arterial vessels which have an aberrant spatial arrangement, disordered (5-8 schematic model presented above). The distorted

circulatory model revealed with greater accuracy by the ultrasound power mode at 3 lymph nodes at which were also present a replacement of space, a lack of central vascular signal and the presence of subcapsular vessels.

The evaluation of the angioarchitecture of the lymph nodes revealed by Doppler ultrasonography can be used in the differential diagnosis of lymph nodes (18, 20). Circulatory changes related to anatomical and structural changes detected by two-dimensional ultrasound tend to raise the degree of accuracy in the identification and classification of lymph nodes.

In the present study, which included the assessment of 38 lymph nodes, we can say that power Doppler technique has greater sensitivity in detecting the Doppler signal frequency and low amplitude than color Doppler method. Power Doppler ultrasound revealed the presence of blood flow in 20% of lymph nodes without color signal and in almost 40% of lymph nodes color Doppler identified a decreased vascular signal. However, power Doppler technique was not superior in detecting a vascular signal compared with color Doppler in hyper vascularised lymph nodes. There must also, be mentioned the possibility of false positive signals at power Doppler evaluation of the axillary lymph nodes, where thoraco dorsal artery pulse covers the pulsations of intra lymph nodal vessels and cause the presence of artifacts. This is the most common cause of damage to power Doppler signal.

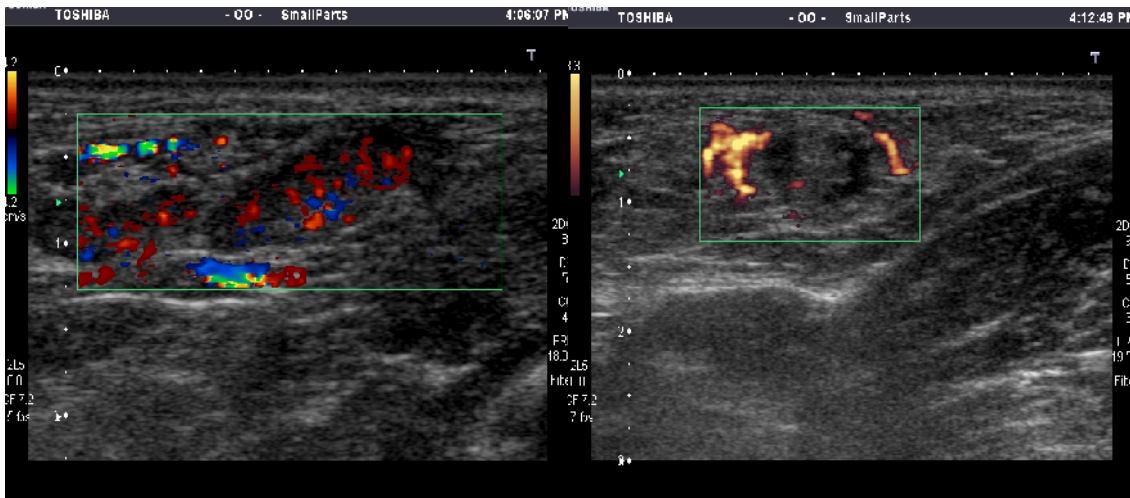


Fig. 4 color Doppler image of inflammatory superficial inguinal lymph nodes, with increased vascular signal evenly distributed.

Fig. 5. Subcapsular vessels setting of a superficial inguinal lymph node cancer, revealed by power Doppler assessment.

Sentinel lymph node status is a prognostic factor in most cases of breast cancer not only to female dogs, especially since the majority of mammary tumors were about to release the lymphatic circulatory system. In this study, we extended the concept of sentinel lymph node and inflammatory lymph nodes to obtain comparative, dynamic, structural and functional information. In recent years many investigators have indicated the occurrence of mammary gland neoplasia, sentinel lymph node excision after identification by invasive methods such lymphography and indirect lymphography. (11). In contrast to these data, our study brings a new perspective for effective, non-invasive, repetitive and reduced cost investigation. The more so as a therapeutic excessive excision approach of a metastatic lymph node involved not only with inflammations or leads without trace: lymphedema, impaired functionality and pain.

CONCLUSIONS

- Power Doppler ultrasonography revealed the presence of a low vascular blood flow and amplitude, with greater accuracy in small lymph vessels;
- Power mode examination is likely to cause artifacts occurrence which may cause false positive results;
- Therefore, we recommend that Doppler examination of superficial lymph nodes is initiated by power equipment or added to color Doppler examination, where there is no or very low vascular signal point.

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