



EFSUMB Course Book, 2nd Edition

Editor: Christoph F. Dietrich

Ultrasound of lymph nodes

Hans-Peter Weskott, Elena Simona Ioanitorescu

¹Ultrasound Department, MVZ am Siloah, Roesebeckstr. 15 30449 Hannover, Germany

²Clinic of Internal Medicine, Fundeni Clinical Institute, Bucharest, Romania

Corresponding author:

Dr. Hans-Peter Weskott

MVZ am Siloah, Roesebeckstr. 15 30449 Hannover, Germany

Tel.: +49 511 9524292

Email: weskotthp@t-online.de

Acknowledgment:

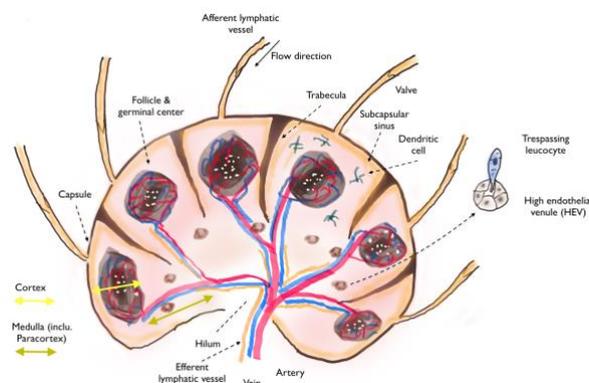
The authors thank Prof. Anthony Rudd and Prof. Yi Dong for review and editing.

General remarks

The lymphatic system consists of a network of interconnected lymphatic channels that collect lymph fluid and carry it to the next lymphatic tissue. It is estimated that approximately 2 liters of lymph fluid is produced within a 24 h period. It is drained from the interstitium by blind-ending lymphatic capillaries. The size of these tiny tubes allows only small molecules and particles (including antigens) to pass through this network. The lymphatic vessels have a valve system that prevents intraluminal fluid from flowing backwards and thus allowing the lymph only to proceed to the next lymph node.

The lymph enters a lymph node by several afferent vessels and is filtered and checked when passing the lymphatic tissue. It passes the subcapsular, peritrabecular space and the medullary sinus [Figure 1]. The cleared lymph is drained by the efferent lymphatic vessels and enters the left and right subclavian vein by the thoracic duct.

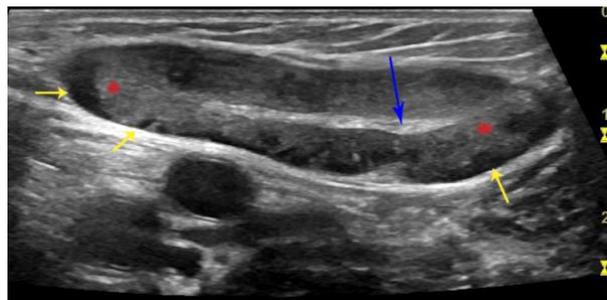
Figure 1 Schematic drawing of a normal lymph node with several afferent lymphatic vessels and usually only one efferent vessel. The lymphatic fluid is filtered and checked for antigens or foreign bodies when passing the cortex and medulla. The lymph node has functional units divided by trabecular septa. Towards the center high endothelial venules (HEV) let leucocytes pass in order to fight intruders being held by dendritic cells. The echo-poor cortex mainly consists of follicles with germinal centers. The hilum consists of echogenic fatty tissue where supplying arteries and veins enter.



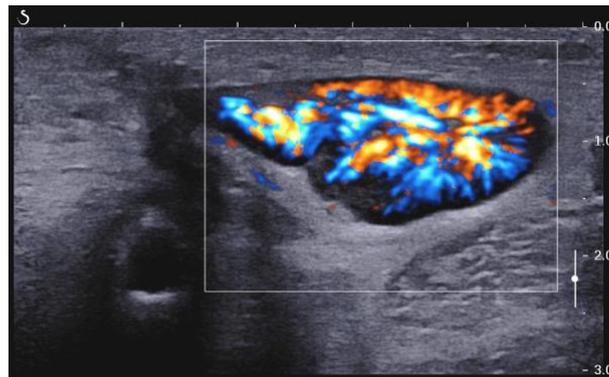
Lymph nodes have a capsule of dense connective tissue that covers the outer part of a lymph node, the echo-poor cortex (B-zone) and more deeply the paracortex (T-zone). From the fibrous capsule trabeculae arise and divide a lymph node in multiple functional areas. The B-zone is located close to the capsule, containing the lymphoid follicles with the germinal center. The paracortex represents mainly the T-Zone, in which the high endothelial venules (HEV) are located. When dendritic cells discover intruders a signal pathway will be activated in order to open a gap between the endothelial cells of the HEV thus letting lymphocytes enter the T-zone. As the travel time for the lymphocytes between exiting the HEV and reentering the systemic circulation is only a few hours, millions of lymphocytes enter and exit each peripheral LN daily (homing). Fluid from the subcapsular and peritrabecular space will also enter the central part of a lymph node. The supplying vessels are found in the hilum of the lymph node. From the hilum regular, tree-like branching vessels pass the medulla and paracortex towards the cortex [Figure 2]. In some lymph nodes accessory arteries and veins may enter and leave the organ somewhere outside the hilum and break through the cortex [Figure 2]. This architecture is typical for most reactive lymph nodes and can be imaged using ultrasound systems with sensitive colour Doppler equipment.

Figure 2 Non-Hodgkin lymphoma with echo-poor follicles (yellow arrow), medulla (red stars) and hilum area with vessels (blue arrow, a). Oval shaped lymph node right groin with a tree like arterial vessel architecture (erysipelas right calf, b). Reactive lymph node with an artery trespassing the node (yellow arrow, c). Reactive lymph node with a vein running through the mid portion of the LN (white arrow point to the cortex, d).

a



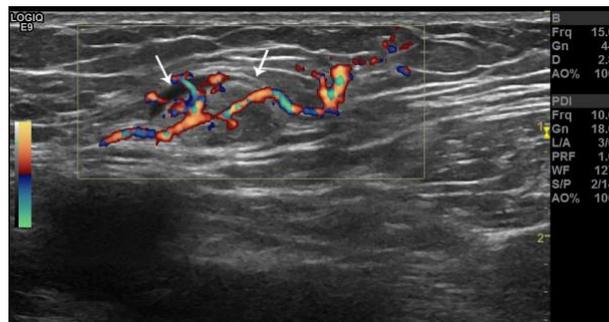
b



c



d

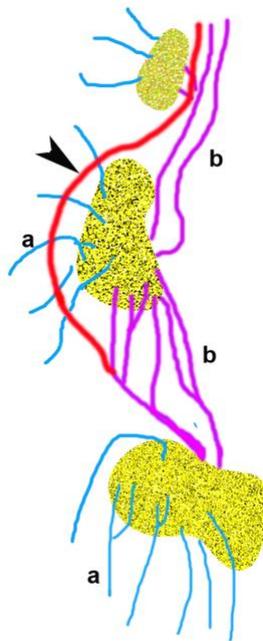


Secondary follicles develop when a lymph node encounters antigens. B cells are found in the center, the parafollicular zone mainly consists of T cells, the sinuses have histiocytes and the medulla is full of plasma cells and lymphocytes.

Beside antigens, which enter the lymph node by the afferent lymphatics, macrophages and dendritic cells enter the lymph node via the lymphatics as well. As soon as the dendritic cells bind an antigen, a signal chain reaction starts aiming at the opening of the palisades of the HEV. Thus, lymphocytes migrate into the interstitial LN tissue and encounter foreign bodies or antigens. Lymphocytes that are not involved in this process leave the lymph node by the

efferent lymphatic vessels. Sometimes an efferent lymph vessel may bypass the next LN, the so-called secondary lymph node [Figure 3].

Figure 3 Lymph nodes with afferent (a) and efferent (b) lymphatic vessels. The black arrow points to an efferent lymph vessel bypassing a lymph node. The efferent lymph vessels may function again as an afferent lymphatic vessel when entering the next lymph node.



Lymphoid tissue is also found in lymphoid follicles (also known as lymphatic nodules) associated with the digestive system such as the tonsils and the Peyer`s patches in the lower gastrointestinal (GI) tract. In contrast to lymph nodes, aggregations of lymphatic tissue have no capsule. In the upper GI tract, they are described as mucosa-associated lymphatic tissue (MALT).

Anatomical remarks and examination technique

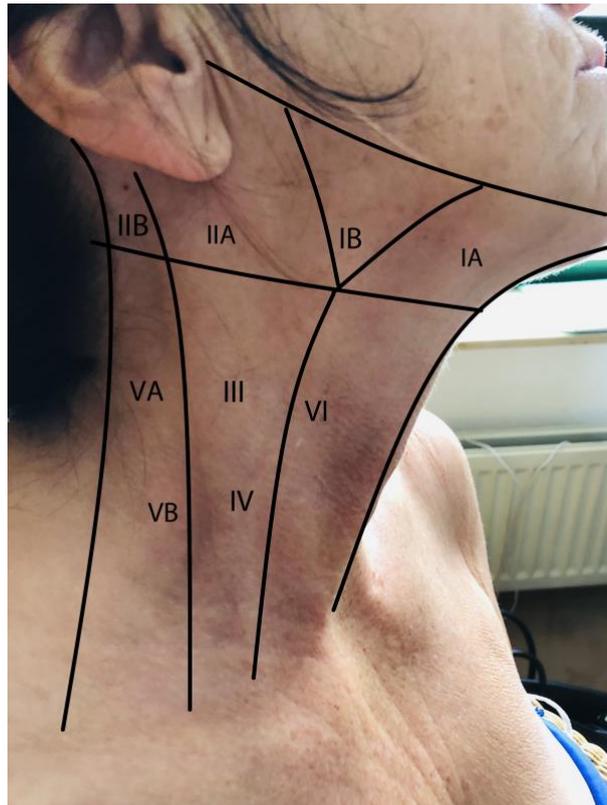
It is estimated that there are approximately 600-700 lymph nodes in humans. The tiny ones whose acoustic properties cannot be differentiated from the surrounding tissue cannot be seen on ultrasound. For the anatomical regions in which transcutaneous ultrasound

examination is not possible such as the mediastinum or perihilar region of the lung, endoscopic ultrasound should be considered, but CT is often the imaging modality of choice. The same is true in patients with unfavourable abdominal scanning conditions. Often the parailiacal region is difficult to image, but a continuous gentle pressure can remove any bowel gas superimposed on the image. A full bladder may act as an acoustic window to image the contralateral parailiacal region in an oblique transducer position. In the evaluation of peripheral lymph nodes, the clinical examination is far less sensitive in the supraclavicular, axillary and infraclavicular regions. The standard protocol for evaluation of the peripheral lymph node state must include the neck, supra and infraclavicular, armpit and groin.

Cervical lymph nodes can be classified into eight regions [1]: the submental (region 1), sub-mandibular (region 2), parotid (region 3), upper, middle and lower cervical (regions 4-6), the supraclavicular fossa (region 7) and the posterior triangle (region 8). Other areas such as the parasternal region in patients with breast cancer or in lymphatic diseases should in these cases be included in the examination process. In patients with melanoma, located distal to the elbow or the knee, the cubital or popliteal fossae should also be checked.

Within the abdominal space the regions of interest depend on the underlying disease. In cancer the lymphatic pathways of the diseased organ are used to identify the lymph node involvement, which usually accompanies the supplying vessels. In inflammatory or lymphatic disease, the involved abdominal and peripheral lymph nodes must be examined, and location and size of involved lymph node must be documented for follow-up examinations [Figure 4]. Volumetric measurement, panoramic view or three-dimensional imaging may help to better demonstrate local lymph node status especially in follow up studies.

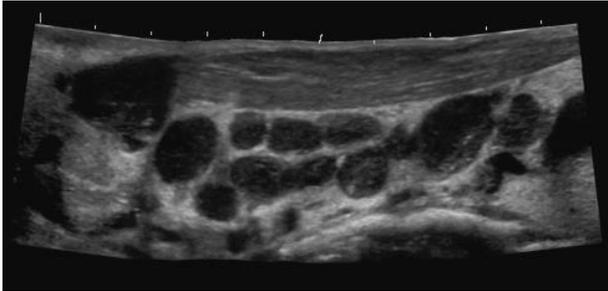
Figure 4 Schematic diagram of neck shows classification of cervical lymph nodes in sonographic examinations.



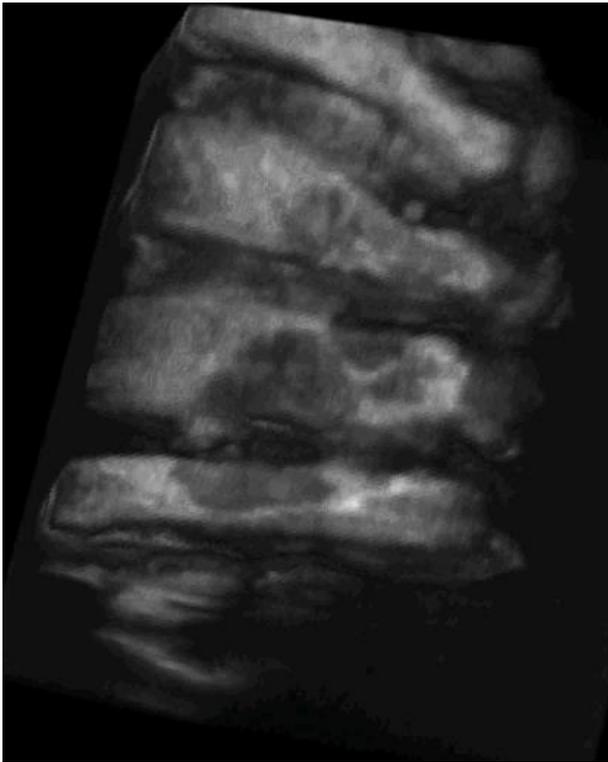
Depending on the depth and local scanning conditions a linear probe or in deep located areas a curved array with the highest frequency (ranging from 4-5MHz to 18MHz) should be chosen. Transmit frequency and depth define the attenuation of the LN embedded tissue (like posterior to muscle or a scar). A panoramic view technique or 3D mode may be advantageous in demonstrating a lymph node in a greater topographic perspective [Figure 5].

Figure 5 C-plane images from a 3D tissue block: Multiple lymph nodes in the neck in a Non-Hodgkin Lymphoma patient (a). Parasternal enlarged lymph node between the ribs demonstrated in a c-plane image (b). After lymphadenectomy a local tumour recurrence was best seen adjacent to the scar on a c-Plane image in a melanoma metastasis patient (c).

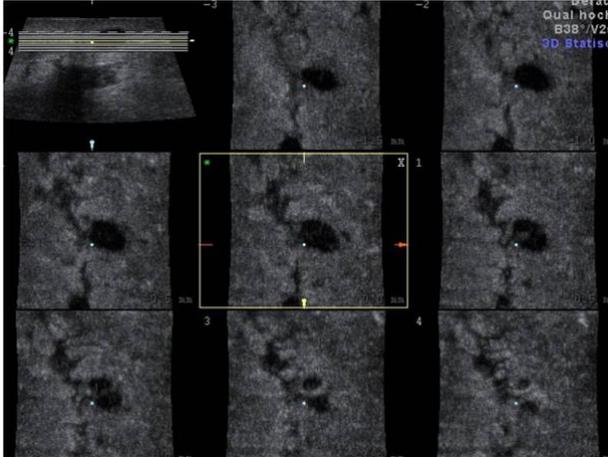
a



b



c



C-level images taken from 3D tissue volumes may help to better demonstrate the topography of diseased lymph nodes. Figure 4 shows location of soft tissue melanoma metastasis in the right groin and parasternal lymph node of Non Hodgkin Lymphoma (NHL). A sensitive colour Doppler technique is needed to image the vascularity of a lymph node, especially its architecture and the presence of arterial and venous flow. Reactive lymph nodes have hilar vascularity or in a chronic state appear to be avascular with a very thin cortex (2). Colour Doppler (bidirectional), power Doppler, B-flow or SMI modes are the preferred flow detection modes. Some ultrasound devices offer B-flow or SMI technique, which have the advantage of avoiding blooming artefacts and can therefore image very small vessels.

Colour Doppler techniques can image larger vessels if the signal strength reflected from the red blood cells is strong enough. In order to image a lymph node`s microvasculature ultrasound contrast agents must be used (see EFSUMB guidelines for extra-hepatic indications). Mechanical pressure by the probe must be avoided when examining superficial lymph node vascularity, as blood flow may be reduced or even blocked [Figure 6].

PREVIEW CHAPTER ONLY FOR THE REMAINING 52 PAGES PLEASE PURCHASE THE FULL CHAPTER. You can purchase the full chapter for just 2.99 GBP by clicking on the link below and completing your purchase on the Secure PayPal server.

 **PayPal** Check out

The safer, easier way to pay