Lymphatic system structure

Author: Maria Yiallouros, erstellt am: 2016/11/30, Editor: Maria Yiallouros, English Translation: PD Dr. med. Gesche Tallen, Last Modification: 2016/12/06 Contents Lymphatic system consists of all lymphotense vessels and lymphoid organs. For example, lymph nodes, spleen, thymus, as well as lymphatic tissue found in the small intestine (Peyer patches) and throat (adenoid tonsils, palatin and tubal tonsils), these are just a few, all lymphatic organs. Thus, instead of representing a single organ, the lymphatic system includes a network of blood vessels and lymphoid tissues and cells in each part of the body. It works closely with the blood-producing (hematopoetic) system in the bone marrow, thereby adding a vital role to the immune response to protect the body from various pathogens. In addition, a network of lymphatic vessels helps transport nutrients and waste in the body. Lymphatic and lymphatic vessels The lymphatic system with the vessel network is – without the circulatory system with which it is closely related – the most important transport system of the human body. The human body produces about two liters of lymph every day. This clear to yellow liquid is formed when the blood plasma comes out of the capillary vessels and fills small spaces (interstices) between the tissues and cells of the body and around them before collecting through small lymphatic vessels (lymphatic capillaries). Lymph transports nutrients and oxygen cells, as well as immune cells (such as lymphocytes). When circulating through interstitial sections of various tissues, lymph also takes most of the body's waste and carbon dioxide. In addition, lymph transports fat from the intestine to the bloodstream. After it has been collected by lymph capillaries, the lymph is transported through larger lymph nodes to the lymph nodes, where lymphocytes clean it before emptying it into large (subclave) veins close to the heart, where it re-merges with blood. Lymph nodes The network of lymphatic vessels includes several interposed lymph nodes, small organs of lentil or bean size. They serve as lymph filtration stations in a certain region of the body and contain special cells of the immune system, lymphocytes that fight infections that attack the body. Thus, lymph nodes cleanse the lymph and free it from pathogens and infectious bodies. The network of lymph vessels includes several interposed lymph nodes, small organs of lentil or bean-sized organs. They serve as lymph filtration stations in a certain region of the body and contain special cells of the immune system, lymphocytes that fight infections that attack the body. Thus, lymph nodes cleanse the lymph and free it from pathogens and infectious bodies. The spleen and thymus spleen are the left upper abdominal organ. Its work is to process old and damaged blood cells and microorganisms. Before birth, the spleen also helps to produce blood cells. In childhood, it plays an important role in the development and maintenance of the immune system. Thymus is a gland located behind the sternum (sternum). At birth, thymus is the largest organ of the lymphatic system. It plays a vital role in the development of the immune system. Thymus is also considered a T-lymphocyte school (T, like Thymus) because it teaches this subset of lymphocytes to distinguish between the body and foreign immune cells. This means that T-lymphocytes in the thymus gland are learning and therefore mature to be functional defense cells. The organ grows to puberty. In adults, it loses its size and relevance, and its lymphatic tissue is most often replaced by fat cells. Lymphocytes – lymphatic

system cells Lymphoid cells, lymphocytes, are a subset of white blood cells. They play an important role in the body's immune defense, since they can target and eliminate pathogens. Lymphocytes are formed – like all other blood cells (e.g. all white and red blood cells, as well as platelets) – in the bone marrow, where they come from blood precursor cells called blood stem cells (haematopoietic stem cells) and mature step by step. Direct cells of lymphocyte precursors are so-called lymphoblasts. Passing several stages of development, both in the bone marrow and in various lymphatic organs (for example, lymph nodes, spleen, thymus), they change their shape and properties. When their development is completed, mature lymphocytes, thus acting, are ready to leave the bone marrow or lymphatic organs to carry out their work in the blood and tissues. Mature T and B lymphocytes later reach downstream lymphatic organs such as the spleen, lymph nodes or tonsils. Both groups of lymphocytes serve the body's immune defense, but with different functions. Depending on where their final puberty took place, lymphocytes are divided into two main groups: B-lymphocytes and T-lymphocytes. B-lymphocytes mature in the bone marrow, and the maturation of T-lymphocytes occurs thymus. Mature T and B lymphocytes later reach downstream lymphatic organs such as the spleen, lymph nodes or tonsils. Both groups of lymphocytes serve the body's immune defense, but with different functions. Lymphocyte function The main task of mature B-lymphocytes, also known as plasma cells, is to produce antibodies. These are small protein molecules that stick to pathogens, thus making them recognizable enemies, which must be covered, digested or killed, respectively, by the so-called guzzle cells (macrophages) or natural killer cells (special T-lymphocytes). Natural killer cells are a subset of T-lymphocytes that can recognize and subsequently remove virus-infected cells, as well as cancer cells. Other T-lymphocytes help the body remember certain pathogens from previous contacts. These memory basically organize the mission of immune cells, thereby activating or suppressing the activity of the immune system. Different subgroups of lymphocytes work together to perform their immunodefensive work. They communicate through certain cell messengers (hormones), lymphokinus. Together, the lymphatic system is a complex network of cells, tissues and regulatory mechanisms, all working together to coordinate the body's immune system. In this article, the first of a series of six parts, an overview of the lymphatic system that circulates lymph fluid around the body to drain tissue, transport fat and activate the immune response This article is the first in a six-part series about the lymphatic system. It discusses how the system is structured and how it works, focusing on tissue drainage, fat transport and activation of the immune response. It also investigates the causes, symptoms and treatment of edema. Paragraph 2 will focus on lymphatic organs, section 3 will examine immunity in more detail, section 4 will discuss allergies, anaphylaxis and anaphylactic shock, paragraph 5 will focus on vaccination and immunological memory, and paragraph 6 will discuss immunotherapy. Quote: Knight J, Nigam Y (2020) Lymphatic system 1: structure, function and edema. Nursing Times [online]; 116: 10, 39-43. Author: John Knight is an associate professor of biomedical sciences; Yamni Nigam is professor of biomedical sciences; and Swansea University College of Human and Health Sciences. This article was a double-blind reviewed scroll down to read the article or download a printable PDF here (if the PDF fails to fully download, try again using another browser) Click here to see other articles in this series This is the first six-part series article examining the lymphatic system and immunity. It reviews the structure and function of the lymphatic system, focusing on its role in tissue drainage. It also examines factors that can damage lymphatic flow, briefly examines the role of the lymphatic system in fat transport and introduces overlap and synergy of the lymphatic and immune system. Edema, which occurs due to poor drainage of the lymphatic system, commonly called lymphoedema Lymphoid system Lymphatic system can be considered a second circulatory system, which acts in parallel and in combination with the cardiovascular system; it extends to every major region of the body except the brain and spinal cord (Moore and Bertram, 2018). The main anatomical components of the lymphatic system are highlighted in Figure 1. Lymphatic vessels form the pipelines of the lymphatic system, and through them passes a watery liquid called lymph; the term lymph comes from the Latin word lymph, that is, water. Unlike the cardiovascular system, the lymphatic system is not a closed system and does not have discrete pumps similar to Heart. But in many ways, lymphatic vessels are structurally similar to veins: they have relatively thin walls and carry lymph at low pressure. For this reason, like the veins, most larger lymphatic vessels are equipped with valves to prevent lymphatic reversible flow under the influence of gravity. Lymph flows through several major lymphoid organs, where its composition is monitored and modified. Lymphoid organs are divided into: primary lymphoid organs (red bone marrow and thymus gland), in which lymphocytes are formed from immature precursor cells; Secondary lymphoid organs (spleen and lymph nodes) in which lymphocytes live and are arranged for the immune response. The location and roles of lymphoid organs are summarised in Table 1 and will be further explored in the following articles of this series. The lymphatic system has three main functions, which are discussed here: tissue drainage; Fat transport; Immune response. Tissue drainage Interstitial fluid formation The left ventricle of the heart displaces oxygen-rich blood under high pressure into the aortic, which is the main systemic artery. Large arteries stretch from the aorta to provide the upper and lower regions of the body with blood. In the organs, the arteries are divided into gradually smaller vessels and eventually into the smallest arteries of the body, which are thermally arteries. Most arteries bind to capillary beds, which permeate into tissues (Figure 2). The main role of capillaries is to distribute blood, ensuring that adequate oxygen and nutrients are supplied to all cells, while simultaneously acting as pipelines: collection of metabolic waste, such as carbon dioxide (CO2); Cell signals, such as hormones. Blood flow to capillary beds is regulated by small smooth muscle rings, called pre-capilla sphincters; when they are dilated (open), blood from the arterioles flows under high pressure. In most tissues, the capillary walls are porous, which allows the liquid to be driven through the capillary walls by filtration. Since this liquid gathers in small interdial spaces that surround cells, it is called interstitial fluid or tissue fluid. The interstitial fluid bathes in many human cells and has a composition similar to that of the plasma, minus the larger plasma proteins that are too large to physically pass through the pairs of capillary walls. The average adult human body has about 11-12L of interstitial fluid filling interstitial spaces, where it acts as the main exchange medium in many human tissues. Freshly produced interstitial fluid is a complex mixture rich in oxygen and several other components, such as: Sugar (primarily glucose) – for metabolism; Amino acids – for the construction of proteins; Lipids – for the metabolism and synthesis of cell membranes and chemical signals such as hormones; Electrolytes, including sodium, potassium, calcium and chloride it is necessary to osmotic and/or electrochemical balance and as common factors for enzymes and structural cell proteins; Hormones – to regulate internal physiology and ensure homeostasis; Wastes from cell metabolism, including CO2 and nitrogen waste such as urea and uric acid. Since the interdious fluid is pushed out of the arterial end of the capillary bed, the remaining blood in the capillaries is thicker and viscous, so it moves more slowly. It also has a higher concentration of soluble substances such as plasma protein albumin and fibrinogen, which exert osmosic traction. As a result, the interstitial fluid, which has a large number of metabolites of waste, returns to the bloodstream towards the venous end of the capillary bed, eventually draining into the veins, which will be carried away in the venous system. Interstitial fluid drainage and lymph formation Approximately 85% of fluid lost at the end of the capillary artery regenerates into the bloodstream at the end of the veins (Herlihy, 2018). The remaining 15% is added to the interstitial fluid, bathing the cells. Since this process is eternal, the interstitial fluid around the cells is constantly updated and replaced. In addition to proper drainage, an excess of interstitial fluid can accumulate in the tissues, which leads to swelling (edema) and, perhaps, compression of local blood vessels and subsequent tissue damage. The main role of the lymphatic system is to constantly collect excess interdedoric fluid and drain it from the tissues. Among the capillary beds intertwined are blind lymphatic capillaries (Figure 2); the walls of these vessels consist of cells which form overlapping flaps that act as unidirectional mini-valves. Very porous, they act as sponges, soaking excess fluid from the space of the mouth. Unlike larger lymphatic vessels, these lymphatic capillaries do not have muscle walls or internal valves; therefore they rely on capillary action to draw excess fluid from the tissues and transfer it to gradually larger lymphatic vessels. As soon as the interstitial fluid enters the lymphatic capillaries, it is called lymph; At this stage, the newly formed lymph is usually a transparent, transparent liquid, similar to water. Lymph movement Previously, it was believed that the movement of lymph through the lymphatic system was a passive process, dependent on physical movements of the body. As in the case of veins, the contraction of skeletal muscles compresses the lymphatic vessels, increasing the pressure inside with the internal valves in medium and larger lymphatic vessels, ensuring the progressive movement of lymph upstream. Although the movement of the body plays a crucial role, it was later found that in the walls of larger lymphatic vessels there is a specialized muscle type, which is structurally intermediate between smooth muscles that correspond to the arteries and veins, and the heart muscle located in the heart myocardium (Scallan et al, 2016). This unique type of muscle is actively in the case of rhythmic waves (similar to gastrointestinal peristatic movements), ensuring progressive, constant lymph movement. These rhythmic contractions of the walls of the lymphatic vessels complement the movement of lymph, which is formed during the movement of the body; they also ensure proper movement of lymph while the body is standing or is resting. Lymph composition Initially in smaller lymphatic vessels, derived from the beds of tissue capillaries, lymph is usually clear or straw-colored, similar to plasma. This reflects its origin, and it is chemically almost identical to the interstitial fluid. But by the time he reaches the larger lymphatic vessels, he mixed with fatty digestive products and acquires a cloudy or milky appearance; at this stage it is called chyle. The return of lymph to the cardiovascular system Lymphatic system eventually enters the lymph vessels of a larger diameter, called lymphatic strains, which contain strong valves, ensuring that the lymph is gradually transported upwards from gravity pulling. The largest of the lymphatic vessels is the thoracic canal, which is usually 50-70 mm in diameter and has about 75% of the body's lymph (Johnson et al, 2016). As the name suggests, the thoracic canal carries the lymph upstream through the thoracic cavity (Figure 1); lymphatic flow is helped by normal breathing movements, which rhythmically compress the walls of the thoracic canal, effectively creating a milking effect. The thoracic duct ends and releases its contents into the left vein of the subclave, ensuring that the volume of blood is maintained by processing the fluid that was obtained from the blood during capillary filtration. In the place where the duct empties into the vein of the subclaves, a small bicuspid valve prevents the reversible flow of venous blood into the lymphatic system (Ilahi et al, 2020). Chest injuries, for example, after an accident can lead to a rupture of the thoracic canal and a chyle leak into the laceration cavity. This type of robbery is known as chylothorax and can cause lung compression, making it difficult to breathe. Chylothorax may also cause accidental injuries to the thoracic canal during surgery or by clogging the thoracic canal, such as malignancies such as lymphoma. This increases hydrostatic lymph pressure and causes chyle leakage (Rudrappa and Paul, 2019). Edema and lymphoedema Edema can be defined as excessive accumulation of fluid in the interstitial spaces, which leads to visible swelling of soft tissues. Since edema is an object of gravity, it becomes more evident in the distillas of the lower extremities and is often especially noticeable in the ankles and legs. Most edema is called pip edema, because when pressing the area, a pit is formed, because the liquid is pushed off; the pit slowly disappears after a few seconds when the liquid returns. Edema can have various main causes; the three discussed below are poor increased vascular permeability and poor drainage of the lymphatic system. Poor venous return is usually seen in the case of right-handed heart failure, when the right side of the heart becomes less effective in collecting venous blood from a weaker and higher vein cava and pumping it through pulmonary lung circulation. This leads to a spare part of venous pressure, reduces the intermediate reabsorption of fluid and clearance from capillary beds. Peripheral edema of this type is especially noticeable in the lower extremities, swelling of the ankle and feet is often observed. In the later stages of heart failure, edema can become so severe that the fluid leaks through the skin of the legs (crying edema) or collects fluid-filled blisters (Aviles, 2019). Long periods of immobility, such as long-term hospital bedrest, also reduce blood flow in the veins of the legs and can lead to venous stash and reduced venous return (Knight et al, 2018). Many women experience mild edema in the later stages of pregnancy, when large veins, such as inferior veins cava in the abdominal area, become compressed as the baby grows; this often leads to fluid accumulation and swelling in the legs. Increased vascular permeability is often observed in areas of infection, irritation or injury, where inflammatory mediators, such as histamine and prostaglandins, promote the relaxation of the intermittent cell junctions of the capillary walls. As a result, an outflow of inflammatory exudato occurs, which accumulates in the inter-space. Increased vascular permeability can also be associated with fluctuations in the female sex hormone estrogen, which occur during the menstrual cycle and during pregnancy. Edema, occurs due to poor drainage of the lymphatic system, commonly called lymphoedema. In the UK, this is most commonly associated with cancer caused by blockage caused by the spread of metastatics, or after surgery to remove local lymph nodes. For example, in most cases of breast cancer, it is recommended to remove axillary lymph nodes (axillary autopsy). Drainage of the lymph of the arm usually passes through the axilla, so axillary outcry can cause pronounced lymphoedene of the arm (Figure 3). Symptoms include severe, painful limb and weakness. Untreated, it can progress to chronic lymphoedetic and, in severe cases, the formation of solid fibrous tissue, which inhibits the supply of oxygen to the affected areas. Patients may become prone to recurrent skin infections and develop skin ulcers that are difficult to cure. Severely obese patients with a body mass index (BMI) over 50 are also prone to lymphoedene, which in most cases can be severe and disfigured. The link between extreme obesity and lymphoedetics is unclear. However, there was a hypothesis that increased accumulation of fatty tissues can shrink lymphatic vessels, reduce tissue drainage, and increased inflammation can damage lymphatic vessels, reduce tissue density and ability to collect and pump lymph (Nitti et al, 2016; Greene et al., 2015). Complete blockage of lymphatic vessels can lead to extreme lymphoedesis called elephantiaze. Bites of mosquitoes infected with Filarial elephantiasis in tropical regions transmit microscopic, threaded, philarial worms. Parasites enter the lymphatic vessels and are transported to regional lymph nodes, where they cause large cases of blockage in a disease called lymphofine filariasis, which can cause lymphoedetics (Mohammad, 2018). Since lymphatic filariasis occurs mainly in poor urban and rural populations, lymphoedema often remains untreated and develops into irreversible elephantiasis. In 2018, 893 million people in 49 countries Treatment of lymphoedaticsema There are several treatments to reduce chronic lymphoedene, including: manual lymphatic drainage (MLD), which includes a gentle, rhythmic massage that stimulates the flow of lymph; Complete decongesic therapy, which includes therapeutic exercise, the application of short stretching compression bandages, skin care and MLD; Consistent gradient pump therapy, which helps to break down fibrotic tissue to re-enable lymph movement. The transport of fat in the digestive tract is mainly absorbed by nutrients in the lium, which contains small, finger-like projections called wool, which massively increase the total surface area. Each wool contains a complex, highly concentrated network of blood capillaries and a central blind lymphatic vessel called lacteal (Fig. 4). After mechanical and chemical digestive processes, carbohydrate digestion products (monosaccharide sugars such as glucose) and protein digestion (amino acids) are absorbed directly through the walls of wool into the network of blood capillaries and transported to the liver through the vein of the liver portal. Higher chain fatty acids do not enter the blood directly; instead they enter the cells of the column epithelium, lining the wool, and are covered and packed with a mixture of cholesterol and protein formed by small spherical aggregates called chylomicrons, which are then absorbed directly into the central lacteal of the lymphatic system (Nigam et al, 2019). The lymphatic system is the main means of transporting fat digestive products and, although it has many modified lipids, it does not appear to be sensitive to the accumulation of fat plaques that can affect the arteries. Many women experience mild edema during pregnancy; this often leads to fluid accumulation and swelling in the legs Immune response Almost all tissues of the human body are drained by the lymphatic system, so any infections of organs or tissues usually cause the amount of pathogenic particles circulating in the lymph– bacteria, viruses or fungal cells. The whole lymphatic system Collections of lymphoid tissue, called lymph nodes, contain and process pathogens and activate a specific immune response, which eventually leads to the destruction of pathogens. Adults usually have about 600 of these bean-shaped nodes, which differ in size and usually increase, become mild and inflamed in case of infection (Mohseni et al, 2014). Enlarged lymph nodes are called lymphadenopathy; swollen, tender nodes are usually easily palpable by experienced doctors. The evaluation of lymph nodes can provide valuable diagnostic information about possible sites of infection – for example, cervical lymph nodes usually indicate lymphadenopathy in upper respiratory tract or middle ear infections. The role of lymph nodes in the sequestration of foreign bodies and the participation in immune responses will be thoroughly investigated in the third part of this series, which examines the immune response mediated by antibodies. The main things the lymphatic system operates in parallel with the cardiovascular system and has a network of blood vessels and major lymphoid organs System circulates lymph around the body, drains tissues, transports fat and activates the immune response Excessive accumulation of lymph causes swelling of soft tissues called edema; this includes lymphoedene caused by poor lymphatic drainage Also in this series References Aviles F (2019) Management of chronic wound edema of the liver leg. Today's wound clinic; 13: 9, 30-31. 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