CONSIDERATIONS ON ANATOMY AND PHYSIOLOGY OF LYMPH VESSELS OF UPPER AERO DIGESTIVE ORGANS AND CERVICAL SATELLITE LYMPH NODE GROUP

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CONSIDERATIONS ON ANATOMY AND PHYSIOLOGY OF LYMPH VESSELS OF UPPER AERO DIGESTIVE ORGANS AND CERVICAL SATELLITE LYMPH NODE GROUP (Abstract): The almost constant local regional development of the cancers of upper aero digestive organs requires the same special attention to cervical lymph node metastases, as well as to the primary neoplastic burning point. The surgical therapy - alone or associated - has a mutilating, damaging character, resulting in loss of an organ and function, most of the times with social implications, involving physical distortions with aesthetic consequences, which make the reintegration of the individual into society questionable. The problem of cervical lymph node metastases is vast and complex, reason why we approached several anatomical and physiological aspects of lymph vessels of the aero digestive organs. Among the available elements during treatment, the headquarters of the tumour, its histologic degree, and its infiltrative nature, each of them significantly influences the possibility of developing metastases. Keywords: TOPOGRAPHIC ANATOMY, EMBRYOGENESIS, LYMPH NODES, HEADQUARTER OF TUMOR, HISTOLOGIC DEGREE, INFILTRATIVE NATURE.

Taking into account the fact that the lymph from the entire body drains into the large vessels on the base of the neck, the research area of specialties extends in other medical fields too, in the event that the primary lesion is not detected in the head and neck.

Our knowledge on lymphatics of the neck is based on the works of Barteis, Iosipow, Kessel, and Octaviani, and especially on Rouviere’s descriptions which are nowadays the starting point of study for every specialist (1).

On the basis of 600 various jugular carotid dissections, it results a description of position of pathologic lymph nodes, that is useful for completions on neck dissection (2).

**General embryogenesis concepts**

The lymphatic system is born phylogenetically and ontogenetically later than the blood system. Starting with the third embryonic month, the lymphatic meshwork communicates with right and left upper cardinal vessels through an orifice equipped with a valve. In the place where the lymph nodes will be formed, bundles of vessels appear, in whose loops mesenchymatous elements gather, lymph cells
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arise, and the fibrous capsule is already shaped in the fifth month (3).

From marginal sinuses lymph vessels grow, which penetrate the parenchyma towards the hilum. At birth, the lymph nodes are formed organically, except for the ones that are born secondarily, postnatal. The weight of the lymph node system is 1% of the body weight.

This tissue is best developed around the age of 14-15 years old, coinciding with the complete growth of the adrenal gland (4).

From here on, it starts a slow atrophy process, stronger and stronger as years pass. There won’t be a total regress, since they can react inflammatory or neoplastic any time, outreaching their initial volume (5).

**General structural features of vessels and cervical lymph nodes**

The cervical lymph system is formed of lymph vessels and capillaries, lymph nodes, and terminal collectors on the base of bilateral neck. As Rouviere (1) described, each lateral cervical area contains 23 - 48 lymph nodes (1).

Zechner believes that 1/3 of the total of approximately 400 lymph nodes in human body is located in the neck (6). Royster, dissecting the operatory parts of 39 radical neck dissections identifies, through histologic studies, lymph nodes of various sizes, ranging from 1 cm to 1.5 mm in diameter. Under these conditions, in a cervical dissection, approximately 146 ganglionic formations are collected. It is remarkable that the lymph nodes that were detected microscopically were found metastasized, therefore several authors concluded that the ganglionic dissemination is not directly proportional to their size (7).

In normal physiological conditions, lymph nodes are usually bean-shaped, smooth, soft and elastic. Structurally, they are surrounded by a fibrous capsule, and inside there are parenchyma areas: the outer cortical area and the inner medulla (3). The lymphoid tissue is organized in follicles in cortical area and follicular cords in medulla, being formed of a reticule in which there are lymph cells (lymphoblasts), which will generate lymphocytes. The capsule sends interfollicular septa through the cortical area, which are continued in medulla through intercordonal septa up to the hilum (6, 7).

The circulation pathways of the lymph into the lymph nodes are perifolicular sinuses in cortical area and cavernous pathways in medulla. Lymph capillaries are made of a single endothelium and form a network of various density in connective tissue. The lymphatic vessels have a thicker wall and double valves, bond, open in the direction of the stream and separated by a distance of approximately 1-2. The lymph trunks have, like blood vessels, an intimate layer, the endothelium of the vessel, a medullar layer, formed of smooth muscle fibres, and a connective-elastic layer, called adventitia, more reduced. (7).

**Lymphatic circulation and functions of lymphatic-ganglionic system.**

There are several causes of the progress of the lymph into the lymph vessels, depending on their place.

According to Rouviere, in the area of head and neck, there are two important elements (1): the arterial element, which, during systole sends the arterial beat to the cerebrospinal fluid which sends it further to the lymphatic vessels of the meninges. The absorption power of the lymph vessel during diastole should not be neglected; the
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respiratory element is also valuable for circulation within veins, where the thoracic suction is the main factor of blood progression, therefore of lymph progression (3).

Unlike the large descending cervical and thoracic veins, lymphatic vessels have valves that prevent the retrograde circulation, due to higher downstream pressure than the upstream one, the opposite of venous circulation. The pressure in the thoracic duct increases while expiring and decreases while inspiring. Research conducted by Rouviere and Valette on dogs reveal values of 6 cm³ water, therefore a higher value than the venous pressure of large vessels on the base of the neck, to ease the passage of the lymph into blood (1).

Lymphatic collecting vessels reach the closest lymph nodes, according to Bartels’ law, and, crossing the capsule, open in the marginal sinus. Other times they travel in remote ganglionic relays or the afferent and efferent vessel, or are closely and directly bond through a medullar sinus (3).

All these data may explain why a metastasis does not always undergo all dissemination stages of lymph nodes.

Lymphatic vessels exiting through hilum are afferent lymphatics, but the direction of the stream can change backwards towards lymph nodes, in certain pathological conditions, and then the metastasis might initially arise on hilum. The lymph does not bathe all the parts of the marginal sinus, therefore subcapsular parcelar metastases are possible. Direct links between lymph vessels and veins are rare; only exceptionally a lymphatic vessel can open in thoracic duct. A very important practical aspect, according to Pressman (quote 6), is the direct communication between lymph nodes and blood vessels. Inserting successively air and saline in the lymph nodes of a dog, Pressman observed a direct communication between the lymph nodes and are neighbouring blood vessels, due to the existence of a reach capillary plexus within the lymph node (1,3).

Many remarks revealed that the pressure needed for such substance to enter the blood is lower than the one needed to enter the efferent canals of the respective lymph node. In some cases, the presence of neoplastic cells in blood flow, especially in the area of the lesion, can be thus explained. Lymph is in a diffusion balance with interstitial fluids, respectively with blood plasma, in which the electrolytes, organic and inorganic substances differ little from the ones in blood plasma, except for the concentration of albumin. The walls of lymphatic capillaries are highly permeable and allow diffusion of large molecules and corpuscular tissues, so that lymph is able to transport plasma proteins from interstitial fluids into the blood, regulating the register of plasma albumin. In 24 hours, almost the entire quantity of plasma travels through blood capillaries into interstice, where they are sent back to the lymph. There is a so called lymphocrinia, when some of the secretions of endocrine glands, whose structure contains albumin, reach the general circuit through lymph vessels. Via the thoracic duct, in 24 hours, approximately 2-3 litres of plasma albumin travel, leading to an important loss of lymph during lesions of thoracic duct, with dehydrating effect, with a dangerous deficit of serum albumin; this is also possible during neck dissection on the base of the neck (3).

Lymph nodes have a several functions; the most important ones are:

- Lymphopoiesis. Through their structure, lymph nodes are the most important
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and the most spread wearers of the lymphoreticular tissue. This tissue has a great capacity of cell genesis and formation of lymphocytes which float into the lymph in various mononuclear aspects and from here partially in blood, where they regulate the formula of blood. Formation and number of lymphocytes are regulated by the hormones of the adrenal gland. Hypofunction of this gland causes lymphopenia, while an increase in number of adrenocorticotropic hormones or the action of various stress factors causes lymphocytosis.

- Formation of antibodies. In 1898, Pfeiffer and Mark showed that inside lymph nodes there are antibodies against the choleric vibrio and that in general the titre of the antibodies is higher than the titre of afferent lymph vessels. Recent research has proved that only certain immunologic substances are formed in lymph nodes, together with some of the gamma globulins of plasma proteins, namely, in plasma cells.

- Ant infectious and antitumor filter. In 1860, Virchow described the barrier function of the lymph nodes, afterwards extending this function for toxins, various particles, bacteria, and tumour cells.

This complex function materialises in three aspects: spasms of lymph vessels: Fuldi et al. showed that in the centre of the inflammation, the lymph vessels are clogged by a fibrin clot and distal from it there is a functional closure, a spasm. No doubt that the closure of the lymph pathways as a result of inflammatory oedema prevents the entrance of the toxins and bacteria in inflammatory burning point into the blood; the lymph that reached the marginal sinus and then in other intraganglionic directions decreases the circulation speed and changes the dynamics of circulation. The reticulum of sinus endothelium and the other free reticula enhance this stopping mechanism for foreign bodies, bacteria, and tumour cells. The reticular cells, fixed or free, start an active phagocytosis which becomes the main element of defence.

These defence mechanisms of lymph nodes can be overcome through the increase of the harmful action of foreign agents and, moreover, they themselves can become infectious or tumoral burning points of spreading.

It seems that not all researchers agree to the role of ganglionic filter. Thus, Pressman, conducting research on animals, stated that in reality, lymph nodes have the structure and function of a sponge, and that a mere pressure is enough to express the content, not only in efferent vessels, but also in the blood flow. As a result, during a clinic examination or a neck dissection, one should avoid the compression of suspect lymph nodes, which might contain malignant cells.

The problem of ganglionic filter was raised in order to decide whether to avoid or not the cervical neck dissection. An increase of frequency of metastases was noticed, and researchers concluded that the cervical lymph nodes are a barrier against dissemination of metastases; the lymph nodes can delay individually or as a group the cranial-caudal lymphogenic metastatic process.

Multiple research and clinical observations prove the existence of a defence function, but evidence of destroying the neoplastic cells in the lymph node, as well as a cancercidal function are missing.

The lymph meshwork is extremely developed in the area of inferior and middle nasal fossae, olfactory area and around the
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The olfactory area communicates with the subarachnoid spaces through the lymph vessels which accompany the fillets of the olfactory nerve.

The lymph collecting vessels are directed towards the tubular area, receiving also the lymphatic vessels from the upper side of the veil, after which two pedicles are formed: an external pedicle, which criss-crosses the styloid process and discharges into the main digastric lymph node (Kuttner); a posterior pedicle, more important, which crossing the superior constrictor muscle, drains in Gillette’s retropharyngeal lymph nodes, and after their involution – in the lateral retropharyngeal lymph node in posterior subparotid space. The lymphatics of the sinuses and ethmoidal cells are associated with the ones of the nasal fossae and follow the same destination.

The lingual lymph network is particularly rich and it is grouped in median and lateral collecting vessels. The median lymphatics travel down towards the median glossoepiglottic fold, where, changing direction towards the lower pole of the palatine tonsil on the same or opposite side, meet the lateral lymphatics (12). From here, together, they cross the lateral wall of the pharynx at various heights and in the end they become: some of collecting vessels in Kuttner’s or Most’s subdigastric lymph node; some in the middle jugular lymph node; some in the median lymph node of the spinal chain. Remarkable is the wide array of lateral and heterolateral spreading of lymph nodes of the lymphatics of the base of the tongue, as well as the connections with the lymphatics of the palatine tonsil on its lower pole (10).

Inside the pharynx, the mucous membrane is spread along the entire pharynx, very rich within the piriform sinuses and around Waldeyer’s ring; establishes connections with the lymphatics of the nasal fossae, oral cavity and larynx in the anterior side, downwards connections with the lymphatics of the esophagus and outwards, with Eustachian tube network (13,14).

The collecting vessels are grouped depending on the three distinct regions (nasopharynx, oropharynx and laryngopharynx), with different directions and ganglionic destination.

The lymph on the walls of the nasopharynx is collected in two categories of collecting vessels, median and lateral. The median vessels originating on the floor, Luscka’s tonsil and the posterior wall are the most numerous ones. They cross the two large anterior muscles of the head, tilt outwards and reach the lateral retropharyngeal lymph nodes. Some vessels avoid this stage and end in superior external jugular nodes or lower, in a spinal or subdigastric lymph node; the counter-lateral and bilateral drainage is possible. The lateral lymph vessels cross the superior constrict of the pharynx and discharge in the lateral retropharyngeal lymph node.

The collecting vessels of the oropharynx are grouped in the lymphatics of the palatine velum, palatine tonsils and the pillars of the palatine velum; very rich on the anterior side of the velum, especially on uvula. The collecting vessels have three directions: an anterior lymphatic path, which joins the lymphatics of the cheek and goes downwards to pre- and retrovascular submandibular lymph nodes; a median pathway, which criss-crosses the deep side of digastric muscle and ends in subdigastric lymph node and superior homolateral and counterlateral jugular lymph nodes; a posterior pathway, where they join
the lymphatics of the posterior pedicle of the nasal fossae and end in lateral retropharyngeal lymph node and sometimes in the counterlateral lymph node. There still are connexions between lymphatics of the velum and lymphatics of the palatine tonsil (15).

The lymphatics of laryngopharynx are numerous and large, and, especially on the piriform sinuses, they are grouped as: anterior collecting vessels, which, together with the lymphatics of the supraglottic area of the larynx follow the superior laryngeal pedicle and distribute to subdigastric lymph node or lower, to jugular lymph nodes, located between the thyrolinguofacial and omohyoid trunk; posterior collecting vessels cross the lateral pharyngeal wall and end in lateral retropharyngeal lymph node or superior exterior jugular lymph node (15).

Reference to cervical esophagus alone is arbitrary, due to the fact that the lymph network of the esophageal mucosa is continuous, so that it can drain both into a neighbouring lymph node, and into a lymph node located at a distance from the emission site of the lymph (16, 17).

The deep lymphatic network of the larynx is separate from the counterlateral one by a fibrous commissure that joins the two halves of the thyroid cartilage, distinct in embryonic terms.

The laryngeal lymphatic pathways are linked to the one of the barrier of the tongue and pharynx. As a general remark, the direction of the lymph stream goes upwards from the inferior margin of the cricoid.

Lymphatics of the trachea, although making connections with the subglottic lymphatics, drain especially towards the mediastinal lymph nodes; a subglottal cancer, extended to trachea, will need the therapy of the structures of the neck simultaneously with the therapy of the mediastinum.

Subglottic lymph vessels which receive a small portion of the lymphatics of the vocal cords are connected with the supraglottic lymph vessels through the posterior wall mucosa of the larynx and very few ventral connections (16).

Rejecting the idea according to which the lymph nodes are randomly spread in soft parts of the neck, they form a fixed, well-structured anatomical whole, enough and often complete for stopping any kind of aggression of the lesions of upper aero-digestive organs.

The anatomic study of these groups of lymph nodes is indispensable for understanding the pathogenic concept of cervical lymphadenopathy and for defining the physiologically normal direction of the lymphatic stream (4).

It is necessary to know them, each time a cervical lymph node dissection is performed, be it radical or traditionally functional (2,3).

For practical purposes, without ignoring the continuity of lymphatic system, the surgical anatomy describes several chains of lymph nodes, identified through certain limits, bones or muscles. Neck dissection contains certain chains which, in general, may fit certain geometrical shapes, so that the piece contains a coherent assembly whose sides are dissected (4).

Even if there still are some concerns related to cancerogenic factors, the lymphatic system looks like a unitary whole of performant pathways, which offers the tumour a way to evade, and the tumour will definitely follow it.

Histological research of the tumoral peripheral areas reveals a stroma, a pericarcinomatous reaction which does not limit or
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conclude the process. Thus, there are inflammatory (granuloma), constructive (connective tissue hyperplasia), and vascular phenomena (vascular neoformations), insufficient as barriers, which allow the effraction of tumoral cells from the local cohesion, which will borrow whatever dissemination pathway they find (17, 18). The lymphatic discontinuity causes embolism, usually in the lymph nodes of the first relay, closest to tumour. They have a clinical and diagnostic importance because through their topography they are able to detect the headquarters of the primary lesion.

This rule is not absolute, since there are also abnormal pathways, or by blocking the existing pathways of previous inflammatory processes, the drainage takes place through collateral pathways. One needs to take into account the cross drainage, which can cause counter lateral metastases, solitary in 10% of the cases (19).

Hematogenous discontinuity pathway can usually provide the metastases of sarcomatous tumours and malpighian carcinoma in 45% of the cases.

Continuity pathway presented as neoplastic lymphangitis is observed along the preformed lymph vessels through the lymph sheathes of the nerves (10,15).

Morphological changes of the lymph nodes which are macroscopically visible for the clinician are reactive changes of the lymph nodes, tokens of defence of the reticular endothelial system, characterized by nonspecific reactions which are prone to produce a spontaneous closure of the lymphatic pathways during acclimation of the tumoral cells which reached the marginal sinus, and tumoral changes of the lymph nodes.

Related to reactive changes of the lymph nodes and the way the metastases approaches the lymph node, the most frequent way of dissemination is the orthograde way, and the tumoral graft is located in the marginal sinus of the convexities of the lymph nodes (16, 19).

If a lymph node is blocked by a tumour or inflammation and it is excluded from lymphatic circulation, the afferent vessels enlarge, the stream becomes reverse and it drains randomly, involving tumour cells as well, which explains the appearance of the lymphatic invasion.

CONCLUSIONS

In our evaluations, we can conclude that when the high percentage of responsibility of the lymph nodes was confirmed by statistics, compromising the results through local relapse or remote general metastases, therapists’ main point of interest lays in solving this problem; a cancer whose first treatment failed is definitely lost.

The treatment approach on cervical lymph nodes with metastases evolved in the same pace with the development of general oncology principles and especially cervical-facial cancerology.

REFERENCES