1 The Lymphatic System
Anatomical Bases for Radiological Delineation of Lymph Node Areas

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CONTENTS

1.1 Introduction 1
1.2 Main Collecting Ducts 2
1.2.1 The Thoracic Duct 2
1.2.2 The Right Lymphatic Duct 2
1.3 Lymphatics of the Head and Neck 3
1.3.1 Lymph Node Groups of the Pericervical Circle 5
1.3.2 Descending Cervical Chains 6
1.3.2.1 The Deep Lateral Cervical Chain 6
1.3.2.2 The Deep Posterior Cervical Chain 7
1.3.2.3 The Superficial Lateral Cervical Chain 7
1.3.2.4 The Anterior Cervical Chains 7
1.3.3 Functional Drainage Pathways 8
1.3.4 Delineation of Lymph Node Areas 10
1.4 Lymphatics of the Upper Limbs 10
1.4.1 Axillary Lymph Nodes 11
1.4.2 Superficial Lymph Nodes 11
1.4.3 Functional Drainage Pathways 11
1.4.4 Delineation of Lymph Node Areas 14
1.5 Lymphatics of the Thorax 14
1.5.1 Parietal Vessels and Nodes 15
1.5.2 Visceral Vessels and Nodes 15
1.5.3 Functional Drainage Pathways 17
1.5.4 Delineation of Lymph Node Areas 17
1.6 Lymphatics of the Abdomen 18
1.6.1 Parietal Vessels and Nodes 18
1.6.2 Visceral Vessels and Nodes 18
1.6.2.1 The Pre-aortic Group of Nodes and Their Digestive Affluents 19
1.6.2.2 The Lateral Aortic Lymph Nodes and Their Urogenital Affluents 21
1.6.3 Functional Drainage Pathways 22
1.6.4 Delineation of Lymph Node Areas 22
1.7 Lymphatics of the Pelvis 23
1.7.1 Parietal Lymph Vessels and Nodes 23
1.7.2 Visceral Vessels and Nodes 23
1.7.2.1 Juxtavisceral Nodes 23
1.7.2.2 External Iliac Nodes 25
1.7.2.3 Internal Iliac Lymph Nodes 26
1.7.2.4 Common Iliac Lymph Nodes 26
1.7.3 Functional Drainage Pathways 27
1.7.4 Delineation of Pelvic Lymph Node Areas 28
1.8 Lymphatics of the Lower Limbs 31
1.8.1 Lymph Node Groups 31
1.8.2 Functional Drainage Pathways 32
1.8.3 Delineation of Lymph Node Areas 34
1.9 Conclusions 35
References 36

1.1 Introduction

The lymphatic system is constituted of numerous fine vessels which traverse several groups of nodes and transport the lymph into the venous system. The capillaries of origin have closed extremities which are disseminated within the connective tissues beyond the epithelial lining, and which through several interconnecting anastomoses form primary networks which drain the lymphatic fluid into the first collecting ducts. Passing through the successive groups of lymph nodes, these ducts again divide into capillaries and then finally give rise to the larger collecting vessels which are usually two in number: the thoracic duct and right lymphatic duct, which join the left and right brachiocephalic veins respectively.

The lymphatic vessels have very thin endothelial walls, are filled with a clear colourless fluid, and are usually not visible in living tissue so that various staining or radio-opaque substances have to be injected before their distribution and general pathways can be studied. In the small intestine, however, they have a milk-white appearance during the immediate post-prandial period, which explains their original name of lacteal veins. They possess numerous valves which result in a characteristic moniliform appearance and are present in all tissues of the human body except for avascular structures such as the epidermis, the cornea and the cartilage. They are also absent in the brain, spinal cord, and bone marrow.

According to their location, the lymphatic vessels branch into two networks located respectively above and below the deep fasciae. The superficial lymph vessels drain the skin and the subcutaneous tissue and tend to run alongside the superficial veins, though some may be independently situated. Vessels of the deep subfascial network similarly course alongside the
arteries and veins. They are connected to the nodes and unite to form deep main lymphatic channels which are usually located at the outer surface of the large veins. In rare cases, however, some of them may pass behind the venous blood vessels. Such an arrangement, which was already emphasised by Poirier two centuries ago, appears to be of major clinical importance not only for surgical dissection of the lymphatic chains, but also for the radiological delineation of the main lymph node areas which are invariably located on the superficial aspect of the large deep veins.

A relative separation exists between the lymph vessels of the epi- and subfascial plexuses. Nevertheless, anastomoses occur between both networks which as a rule lead the superficial channels to drain into the deeper channels. On the other hand, a large number of connecting channels unite neighbouring ducts so that most of the lymphatic areas of the body communicate freely with the adjacent regions. Major drainage pathways are thus constituted from the proximal capillary networks originating in the peripheral organs through collecting ducts which penetrate the lymph nodes and finally rejoin the main ducts. Some of these pathways cross the midline, while others directly reach the thoracic duct without traversing any node. From one region, several distinct pedicles also extend that reach the same distal destination but take different routes with various intermediate nodal relays. When considering these anatomical aspects, for each organ or topographical area it is possible to define a preferential pathway of lymphatic drainage which is also the principal means of lymphatic spread for neoplastic or inflammatory cells in pathological situations. On this main axis, the first targeted lymph node is called the sentinel node. Nevertheless, the large number of alternative connecting channels, combined with the plasticity of the lymph vessels which have a marked capacity for regeneration after obstruction or damage, provide the lymphatic system with a dynamic functional structure in which all the areas described below have a constant anatomical location, but display variable circulating relationships and a relative independence from the neighbouring regions.

1.2
Major Collecting Ducts

1.2.1
The Thoracic Duct

The thoracic duct (Fig. 1.1) drains the lymph from the subdiaphragmatic part of the body and from the left chest, left upper limb and left part of the head and neck, back into the blood circulation. Originating from the cisterna chyli located in front of the first and second lumbar vertebrae, it enters the thorax through the aortic hiatus of the diaphragm and then follows the anterior aspect of the vertebral column to reach the posterior mediastinum. Usually not visible on computed tomography (CT) or magnetic resonance (MR) images, it occupies a narrow space between the azygos vein on its right, the hemi-azygos vein on its left, the thoracic vertebrae located posteriorly, and the aorta and oesophagus on its anterior surface (Fig. 1.1). At the level of the fourth thoracic vertebra the duct then inclines to the left, running along the posterior aspect of the aortic arch and then along the left side of the oesophagus behind the origin of the subclavian artery. Reaching the lower part of the neck through the left side of the thoracic inlet, it finally arches laterally near the transverse process of the seventh cervical vertebra, crosses over the prescalenic portion of the subclavian artery and finally ends by opening into the area between the left internal jugular and subclavian veins. At this point, a valvular bicuspid system prevents the blood from being sent back into the terminal part of the duct, but sometimes inducing blockage of the latter by metastatic cellular thrombi.

During its course, tributaries from the intercostal and posterior mediastinal nodes flow into the thoracic duct. At its origin in the cisterna chyli, it drains both lumbar trunks that collect lymph from the lower limbs, the pelvis and the posterior abdominal walls, together with large intestinal trunks originating from all parts of the intra-abdominal digestive system. In the neck, the thoracic duct is joined by the left jugular trunk from the left side of the head and neck, the left subclavian trunk from the left upper limb, and the left bronchomediastinal trunk which usually collects the ascending lymph from the left chest viscera together with the parietal lymphatic channel from the parasternal nodes.

1.2.2
The Right Lymphatic Duct

Described by Poirier and Charpy as the great lymphatic vein, the right lymphatic duct (Fig. 1.1) is formed by the union of the right jugular, subclavian and bronchomediastinal trunks which collect the lymph from the right half of the head and neck, the right upper limb, the right side of the thorax and right lung, and part of the convex surface of the