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Course for Second-Year Medical Students

The caval system, the azygos system, and the thoracic duct

Objectives :
To know the location of the superior vena cava (SVC)
To know the roots and tributaries of the SVC
To know the location of the inferior vena cava (IVC)
To know the roots and tributaries of the IVC
To know the azygos system
To know the thoracic duct

I- Introduction :

Venous blood is returned from the body to the right heart by three venous trunks:
The coronary sinus, which drains venous blood from the heart into the right atrium of the heart.
The superior vena cava (SVC), draining venous blood from the supradiaphragmatic part of the body (head, neck, thorax, and upper limbs) into the right atrium of the heart.
The inferior vena cava (IVC), draining venous blood from the infradiaphragmatic part of the body (abdomen, pelvis, and lower limbs) into the right atrium of the heart.
The azygos system forms an anastomotic system between the superior and inferior venae cavae; it is subject to many variations and includes:
On the right: the azygos vein (azygos major vein).
On the left: the hemiazygos vein (inferior hemiazygos or minor inferior azygos vein), and the accessory hemiazygos vein (superior hemiazygos or minor superior azygos vein).
The azygos system mainly drains the posterior thoracic wall.

II - Descriptive anatomy

A - Superior vena cava :

1.Origin: It arises at the level of the posterior surface of the first right costal cartilage by the junction of the right and left brachiocephalic veins.
2.Course: It descends vertically along the right border of the sternum.
3.Termination: Into the upper wall of the right atrium at the level of the second right intercostal space.
4.Dimensions: Length: 7 cm, caliber: 2 cm.
5.Relations: It is covered at its terminal part by the serous pericardium.
The supra-pericardial part is related to:
Anteriorly: the thymus (or its remnants), the pleura, the first two costal cartilages, and the sternum.
Posteriorly: the right lung, the termination of the azygos vein.
To the right: the right mediastinal pleura and the mediastinal surface of the right lung, the right phrenic nerve.
To the left: the ascending aorta.

The pericardial portion:
Anteriorly: to **the right** auricle (right atrial appendage).
To the left: the aorta.

6.Roots of the superior vena cava:

The right brachiocephalic vein:
It is formed by the union of the right internal jugular vein and the right subclavian vein, behind the sternoclavicular joint. It is 3 cm long and descends vertically downwards and to the left.

The left brachiocephalic vein : It is formed by the union of the left internal jugular vein and the left subclavian vein behind the sternoclavicular joint. It is 6 cm long and descends almost horizontally downwards and to the right to fuse with its counterpart.

the venous plane formed by the left brachiocephalic vein is located anterior to the arterial plane formed by the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery.

7.Tributaries (collateral branches):
The only constant tributary **is the azygos vein,** which drains into the posterior surface of the superior vena cava.

B - Inferior vena cava

1.Origin: It arises from the union of the right and left common iliac veins, in front of and to the right of the upper part of the fifth lumbar vertebra (L5).
2.Course: It ascends vertically along the right side of the vertebral column and the right border of the abdominal aorta up to the level of the first lumbar vertebra, where it curves to the right to lie on the dorsal surface of the liver. It then tilts to the left again to reach the diaphragmatic opening located in the central tendon at the level of the ninth thoracic vertebra.
3.Termination: Intrathoracic, into the inferior wall of the right atrium; it is provided with a valve.
4.Dimensions: Average length: 22 cm; caliber is variable, measuring 3 cm at its termination.

5.Relations:

The inferior vena cava is situated almost entirely within the abdomen (in the retroperitoneal space along with the aorta), except for a very small intrathoracic portion.

In the abdominal cavity:

Posteriorly: the psoas muscle, the right side of the vertebral column, the right crus of the diaphragm, and the right adrenal gland; the right lumbar arteries, the right renal artery, the right adrenal artery, the lateral branch of the right inferior phrenic artery, the medial root of the azygos vein, the right sympathetic trunk, and the right greater and lesser splanchnic nerves.

Anteriorly: It is related to the mesentery, the duodenum, the head of the pancreas, the liver, and the right testicular artery (in males) or right ovarian artery (in females).
To the left: The aorta and the right crus of the diaphragm.
To the right: The ascending colon, the right ureter and right kidney, the right adrenal gland, the right lobe of the liver, and the right lateral aortic lymph nodes.
In the thoracic cavity: It is covered by the serous pericardium.

6.Roots of the inferior vena cava:
The two common iliac veins, each resulting from the union of the external and internal (hypogastric) iliac veins. The right common iliac vein is shorter and more vertical than the left. The common iliac veins are devoid of valves.

The external iliac vein is the continuation of the femoral vein at the level of the femoral arch and ascends medial to the psoas muscle to unite with the internal iliac vein.
The internal iliac (hypogastric) vein is short and bulky; it drains all the veins accompanying the branches of the internal iliac artery.
7.Tributaries (collateral branches):
It receives the five pairs of lumbar veins, the two renal veins, the right middle suprarenal (adrenal) vein, the right testicular (spermatic) or ovarian vein, the hepatic veins, and the two inferior phrenic veins.

C - The azygos vein

1.**Origin:** In the thorax at the level of the eleventh right intercostal space, by the union of two roots:
The lateral root is formed by the fusion of the right ascending lumbar vein (resulting from the anastomosis of the five right lumbar veins) and the twelfth intercostal vein.
The medial root: Inconstant, it arises from the posterior surface of the inferior vena cava.
These veins enter the thorax by passing between the two bundles of the right crus of the diaphragm.
2.Course: It ascends along the anterior surface of the vertebral column to the right of the midline up to the level of the fourth thoracic vertebra.
3.Termination: At the level of the fourth thoracic vertebra (T4), it curves anteriorly above the pulmonary root (hilum) forming an arch (aortic/azygos arch) to terminate in the posterior wall of the superior vena cava. A pair of valves is present at the level of the arch of the azygos vein.
4.Dimensions:
Length: 20 to 25 cm in adults.
5.Tributaries (collateral branches):
-The right bronchial veins
-The esophageal and pericardial veins
-The right posterior intercostal veins
-The right superior intercostal vein (it drains the first 3 right posterior intercostal veins)
-The hemiazygos veins (inferior and superior minor azygos veins)
-The 8th left intercostal vein (inconstant).

D - The hemiazygos vein

Also called the inferior hemiazygos vein.
1.Origin: It arises in the abdominal cavity, either as a continuation of the left ascending lumbar vein (resulting from the anastomosis of the five left lumbar veins) or from the union of two roots: a lateral root and a medial root. • **The lateral root** is formed by the union of the twelfth left intercostal vein and the left ascending lumbar vein. **The medial root** arises from an anastomosis between the left renal vein and the left posterior lumbar vein: this is known as the **renoazygolumbar arch**.
2.Course: It ascends into the thorax through the left crus of the diaphragm, running along the left side of the thoracic vertebrae. Upon reaching the level of either the seventh thoracic vertebra, it curves to the right to empty into the azygos vein, or at the level of the ninth thoracic vertebra, it bends to the right to empty into the azygos vein. In this latter case, the eighth left intercostal vein drains into the azygos vein.
3.Tributaries (collateral branches): It receives the lower left posterior intercostal veins (9th, 10th, and 11th), the pericardial veins, the esophageal veins, and the mediastinal veins.

E - The accessory hemiazygos vein (superior hemiazygos vein)

It descends along the lateral aspect of the thoracic vertebrae down to the level of T7, where it curves to the right to terminate in the azygos vein.
It receives the 4th to 7th left posterior intercostal veins, the left bronchial veins, the esophageal veins, and the mediastinal veins.

The thoracic duct

The thoracic duct is the largest lymphatic vessel. It represents an important part of the lymphatic system because it collects lymph from the entire subdiaphragmatic region of the body, the left half of the supradiaphragmatic thorax, the left upper limb, and the left side of the neck and head, delivering it into the bloodstream at the level of the left subclavian vein.
It consists of 3 parts: abdominal, thoracic, and cervical.

II - Descriptive anatomy

1.**Origin:** It arises in the abdomen at the level of the second lumbar vertebra, between the main crura of the diaphragm, by the union of the right and left lumbar trunks and the intestinal trunk. At this level, it forms a dilation called the **cisterna chyli** (or **chylenic cistern / Pecquet's cistern**).

2.Course: It passes through the diaphragm via the aortic hiatus, posterior to the descending aorta. It extends vertically in the thorax within the posterior mediastinum, along the right side of the aorta and to the left of the azygos vein, resting anteriorly on the esophagus. Upon reaching the level of the fourth thoracic vertebra, the thoracic duct inclines to the left, passing posterior to the aortic arch and then posterior to the left subclavian artery.

-It enters the neck, where it curves, describing a downward-concave arch that winds from back to front over the left pleural dome.

3.Termination: Into the left subclavian vein or into the venous confluence formed by the left subclavian vein and the left internal jugular vein.

4.Dimensions: On average, an adult thoracic duct measures 38 to 45 cm in length with a diameter of 6 to 7 mm. In its middle portion, its diameter is 3 to 5 millimeters. The duct features two ostial valves and a dilatation at its termination.

IV - Collateral branches (or afferents):

The thoracic duct receives numerous collateral lymphatics:
1. Phrenic lymphatics.
2. Thoracic lymphatics: Intercostal and posterior mediastinal lymphatics.
3. Cervical lymphatics:
Left jugular trunk: Draining the left half of the head and neck.
Left subclavian trunk: Draining the left upper limb.
4. Left bronchomediastinal trunk: Draining the heart, the lung, and the left half of the thoracic wall.

The right lymphatic duct (Right lymphatic trunk)

It is a lymphatic collector resembling the thoracic duct. It drains lymph from the right hemithorax, the right side of the head and neck, and the right upper limb.
It is short, measuring 1 cm in length, and is located in the superior thoracic aperture along the medial border of the termination of the right anterior scalene muscle. It terminates in the right jugulosubclavian venous junction and features two ostial valves.

Collateral branches (or afferents):

Right jugular trunk: Drains the right half of the head and neck.
Right subclavian trunk: Drains the right upper limb.
Right bronchomediastinal trunk: Drains the right part of the thoracic wall.

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Référence

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