

SUPERIOR VENA CAVA

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I – INTRODUCTION:

The superior vena cava is a large vein formed by the union of the right and left brachiocephalic veins. It returns venous blood from the supradiaphragmatic regions of the body (head, thorax, and upper limbs) to the right atrium.

Relevance of the topic:

The anatomical study of the superior vena cava is important from a clinical and semiological perspective, as it helps explain the various syndromes associated with it, particularly superior vena cava syndrome.

II – DESCRIPTIVE ANATOMY:

1. Situation:

The superior vena cava is located in the anterior and superior mediastinum.

2. Location:

It results from the union of the right and left brachiocephalic veins. The junction angle of the right and left brachiocephalic veins is located in front of the brachiocephalic arterial trunk, behind the first right costal cartilage joint, and at the level of T3.

3. Branches of origin:

a. Right brachiocephalic vein :

Origin – path – termination :

- The right brachiocephalic vein results from the union of the right internal jugular vein and the right subclavian vein, at the level of the inner end of the right clavicle, and is approximately 3 cm long.
- It directs almost vertically downward and to the left, remaining entirely to the right of the midline.
- It terminates at the level of the first right sternocostal joint.

Relations :

Accompanied by a lymphatic chain (right anterior mediastinal), it is positioned as follows:

- Anteriorly : to the sternal end of the clavicle and the sternal part of the first costal cartilage.
- Posteriorly :
 - to the right brachiocephalic arterial trunk,
 - to the right vagus nerve,
 - o and to the internal thoracic artery at its origin.

• To the right:

- to the pleura and right lung,
- to the right phrenic nerve,
- and to the superior phrenic vessels.
- To the left and toward the midline: to the thymus.

b. Left brachiocephalic vein :

Origin – course – termination :

- The left brachiocephalic vein results from the union of the left internal jugular vein and the left subclavian vein, at the level of the internal end of the left clavicle.
- Measuring approximately 6 cm in length, it travels almost horizontally downward and to the right, crossing the midline to merge with its right counterpart at the level of the first right sterno-costal joint.

Relations :

Accompanied by the transverse anterior mediastinal lymphatic chain, it is in relation to:

- Anteriorly :
 - The thymus or its remnants,
 - The left sternoclavicular joint and the manubrium of the sternum.
- **Posteriorly :** The three major trunks arising from segment 2 of the aorta:
 - The brachiocephalic trunk,
 - The left common carotid artery,
 - The left subclavian artery.
 - The left phrenic nerve,
 - The left vagus nerve,
 - The left internal thoracic artery.
- **Superiorly :** The thyro-pericardial aponeurotic lamina.
- Inferiorly : The second segment of the aorta.







4. <u>Course and termination:</u>

- In its course, the superior vena cava trunk moves obliquely downward and backward, contouring the ascending part of the aortic arch, forming a curve with a leftward concavity.
- It terminates at the upper wall of the right atrium, in line with the third costal cartilage and T6.

Note:

In adults, there is no valve separating the superior vena cava from the right atrium. Thus, cardiac contractions are transmitted to the internal jugular vein and can be observed through the sternocleidomastoid muscle: this is the jugular venous pressure in tricuspid insufficiency.



5. Dimensions:

- Length: is 6 to 8 cm.
- Width: is between 20 to 25 mm.

III – ANATOMICAL RELATIONS:

They are distributed in relation to the pericardial serosa that surrounds the superior vena cava in its lower part. There are intra-pericardial and extra-pericardial relationships.

<u>1.</u> Extra-pericardial or supra-pericardial relations :

Measuring 4 to 5 cm in length and relatively superficial, it is in contact with:

- Anteriorly :
 - o The right anterior mediastinal lymphatic chain,
 - The thymus or its remnants,
 - The anterior costo-mediastinal pleural recess on the right,
 - The anterior border of the right lung,
 - The sterno-costal junction, behind which the internal thoracic vessels are applied.

It projects at the level of the sternal extremity of the two intercostal spaces and the second costal cartilage.

• Posteriorly, from top to bottom:

- The right vagus nerve,
- The arch of the azygos vein,
- The right latero-tracheal lymph nodes, located in a right latero-tracheal compartment (Barety), limited by:
 - Anteriorly : the superior vena cava and the right brachiocephalic trunk,
 - Posteriorly : the trachea,
 - On the left: the aortic arch and the brachiocephalic trunk,
 - On the right: the mediastinal pleura and the right lung,
 - Inferiorly :the arch of the azygos vein,
 - Superiorly : the right subclavian artery.
- To the right:
 - The pleura and the right lung,

• The phrenic nerve and the right phrenic vessels.



• To the left: The ascending part of segment 1 of the aorta.

2. Intra-pericardial relations:

It is shorter (2.5 cm to 3 cm) and also deeper.

The superior vena cava traverses the pericardium:

• **The fibrous pericardium**: It ascends over the superior vena cava and merges with its adventitia.

- The serous pericardium: It forms an asymmetric sheath that extends higher on the left side of the vein and is incomplete at the back (engaging only the anterior three-quarters of the vein).
- The line of reflection of the pericardium creates a recess behind, between the superior vena cava and the right superior pulmonary vein: the retrocaval fossa.



a. In the pericardial sac :

Inside the pericardial sac, the superior vena cava is in relation to:

• Anteriorly: the right atrium.

- **On the left**: the first segment of the aorta, separated by the orifice of the transverse sinus of the pericardium (Theile).
- **On the right**: the pericardial cavity.
- **Posteriorly :** the right superior pulmonary vein.



b. Outside the pericardial sac :

The superior vena cava is in relation to:

• Anteriorly: the pleural recess separating it from the sterno-costal plastron; it projects in front of the sternal end of the 2nd intercostal space and the upper border of the 3rd cartilage.

- **Posteriorly**: the right pulmonary pedicle, notably:
 - The right pulmonary artery, resting on the roof of the transverse sinus of the pericardium.

Note: This is a relation used for performing a cavo-pulmonary anastomosis.

- And the right superior pulmonary vein.
- On the right:
 - The pleura and the right lung.
 - \circ $\;$ The right phrenic nerve and the right phrenic vessels.



IV – COLLATERAL BRANCHES:

The main collateral of the superior vena cava is the azygos vein, or the great azygos vein.

1. Azygos vein:

• Origin – trajectory :

- The great azygos vein originates in the infra-mediastinal posterior space at the level of T11, from the junction of its two roots:
 - **The internal root**: Inconstant, it arises from the posterior surface of the inferior vena cava or, in rare cases, from the right renal vein.
 - **The external root**: Constant, it is formed by the fusion of the right ascending lumbar vein and the twelfth intercostal vein.
- The azygos vein then ascends vertically in the posterior mediastinum to the right of the midline. It enters the thorax and follows the right lateral surfaces of the vertebral bodies. At the level of the 3rd intercostal space, it curves forward and passes above the right main bronchus, forming the arch of the azygos.

Termination :

It terminates at the lower part of the posterior face of the superior vena cava, at the level of the 4th thoracic vertebra.

Note: The azygos vein and the veins of the vertebral column constitute an important collateral pathway that drains blood when the vena cava is obstructed.

Dimensions :

- Length: 20 to 25 cm.
- **Caliber**: 4 mm at the origin and 10 mm at the termination.



Anatomical relations :

From its origin to its arch, the azygos vein is in relation to:

- Left: the thoracic duct, and further on, the aorta.
- **Right**: the right mediastinal pleura.
- **Posteriorly**: the thoracic spine and the right intercostal vessels.
- **Anteriorly**: the root of the right lung and the right pulmonary ligament.

At the level of its arch, it crosses over the right main bronchus, the right pulmonary artery, and the right bronchopulmonary lymph nodes. It is in relation to:

- **Right**: the right pulmonary pleura.
- To the left of the esophagus: the right vagus nerve and the trachea.

Affluent veins :

The azygos vein receives:

- Esophageal veins.
- Right bronchial veins.
- Pericardial veins.
- Mediastinal veins.
- Superior phrenic veins.
- Right superior intercostal veins, and right posterior intercostal veins.
- Hemiazygos vein, and accessory hemiazygos vein.

V- COLLATERAL PATHWAYS:

In case of obstruction of the superior vena cava venous system, three anastomotic systems develop depending on the level of interruption:

1. <u>Anastomoses between the brachiocephalic trunks and the azygos system:</u>

In case of obstruction between the confluence of the brachiocephalic trunks and the junction of the azygos vein, the collateral pathways are:

- Internal mammary veins,
- External mammary veins,
- Epicardial-pericardial veins,
- Superior right and left intercostal veins.

2. Anastomoses between the superior vena cava and the inferior vena cava:

In case of obstruction at or below the junction of the great azygos vein, the collateral pathways are:

• The posterior trunk system between the azygos system and the plexus of the spinal column.

• The anterior trunk system between the internal mammary vein and the epigastric vein, between the external mammary vein and the abdominal subcutaneous vein, and between the internal mammary vein, the epigastric vein, and the veins of the round ligament draining into the portal system.

3. <u>Transversal anastomoses:</u>

In case of interruption at the junction of the brachiocephalic trunks, the collateral pathways are:

- The system of thyroid veins.
- The inter-jugular system (internal, anterior, and external).

VI-CLINICAL APPLICATIONS:

Superior vena cava syndrome :

- This refers to the group of symptoms observed when there is an obstruction of the superior vena cava's venous return. The main causes are pulmonary and mediastinal neoplastic conditions.
- Clinical presentations vary depending on the speed at which the obstruction occurs.
- The radiological diagnosis of superior vena cava syndrome is made through a CT angiogram and thoracic magnetic resonance imaging (MRI). Therapeutic management includes immediate anticoagulation followed by a diagnostic work-up to propose an appropriate etiological treatment. Decompression or endovascular revascularization through the placement of a stent may be considered, as well as surgical treatment.

Trauma of the superior vena cava :

- Trauma to the superior vena cava (SVC) is most often iatrogenic, resulting from the increasing use of central catheterization procedures. Iatrogenic injuries can also complicate repetitive sternotomies in cardiac surgery.
- Closed trauma to the SVC is rarely isolated; it typically occurs as part of severe trauma that involves other intrathoracic vascular and visceral injuries.
- SVC injuries from stabbing or gunshot wounds are rarely isolated and are often associated with injuries to the brachiocephalic arterial trunk and the brachiocephalic veins.

VII-SURGICAL APPROACH ROUTES:

Total vertical median sternotomy:

- The incision is median and vertical, extending from the sternum notch to beyond the xiphoid process. After cutting the union of the right and left pectoral muscle fibers along the midline, the presternal periosteum is incised. At the lower part of the incision, the linea alba of the abdominal muscles is cut to free the entire xiphoid process. The sternum is divided along the line of the periosteal incision. The powerful interclavicular ligament is sectioned, allowing the placement of a sternal retractor. The anterior pleural recesses are pushed aside. The residual thymus may be divided with ligatures or freed on its right edge to create a flap hinged on the left to cover any potential cava bypass.
- Access to the entire superior vena cava, both intra- and extrapleural, requires opening the pericardium along an axis from the diaphragm to the aortic reflection line.

Right thoracotomy:

The right posterolateral thoracotomy involves the sectioning of the latissimus dorsi muscle, preserving the serratus anterior muscle by incising the triangular aponeurosis inserted at the lower border of the rhomboid muscle and the posterior edge of the serratus anterior. The incision is made in the fourth intercostal space, which offers the best exposure of the superior vena cava.

Bithoracotomy:

Bithoracotomy combines bilateral submammary anterior thoracotomy with a transverse sternotomy. It provides excellent exposure to both venous trunks and the trunk of the superior vena cava.

VIII- CONCLUSION:

The pathological phenomena of the superior vena cava can be explained by its structure, location, and anatomical relations, which highlights the importance of understanding its anatomy.