INFERIOR VENA CAVA

PR.M.D.EL AMRANI DR.CHAIMA KASSI

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I – INTRODUCTION:

- The inferior vena cava is the main collecting trunk for the veins of the subdiaphragmatic part of the body, draining into the right atrium.
- Located almost entirely within the abdominal cavity (abdominal portion), it passes through the diaphragm and has a short thoracic course (thoracic portion).

II - DESCRIPTIVE ANATOMY:

1. Origin:

The inferior vena cava is formed by the union of the right and left common iliac veins at the level of the fifth lumbar vertebra (L5). These common iliac veins themselves result from the confluence of the external and internal iliac veins.

2. Course:

It ascends in the retroperitoneal space of the abdominal cavity, along the right side of the lumbar spine:

- it follows a vertical course up to L1,
- then becomes slightly oblique upwards and to the right, passing behind the liver,
- and finally takes a slight oblique direction upwards and to the left, just beneath the diaphragm.

It passes through the diaphragm at the level of T9, and then has a short intrapericardial thoracic segment before draining into the right atrium.

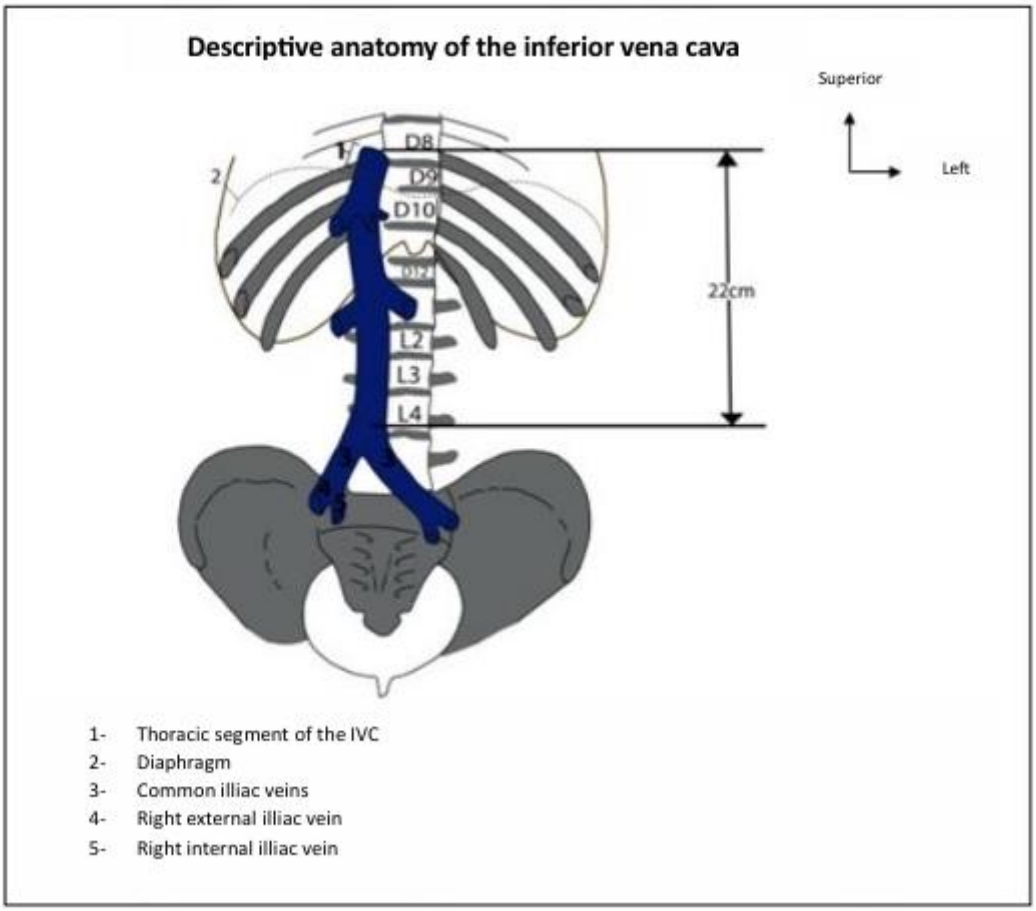
3. Termination:

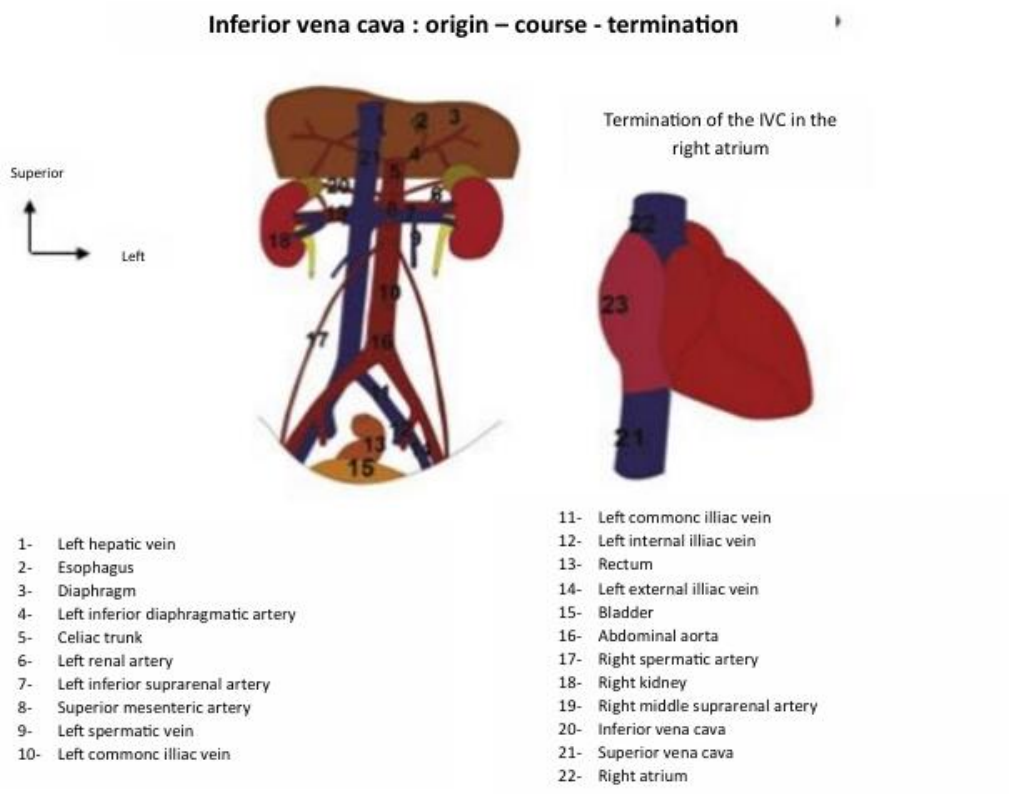
The inferior vena cava terminates in the postero-inferior wall of the right atrium.
Its atrial orifice is guarded by an incomplete valve, known as the valve of the inferior vena cava (*Eustachian valve*).

***Note**: With each cardiac contraction, a portion of blood may be pushed back into the inferior vena cava.*

4. Dimensions:

- **Length**: 22 cm
- **Diameter**: 2 to 3 cm.
- It ascends from bottom to top, with two dilatations:
  - One above the entry of the renal veins
  - And another above the entry of the hepatic veins





III – ANATOMICAL RELATIONS:

1. Abdominal relations :

– The inferior vena cava is accompanied along its course by the lumbar lymph nodes: *precaval, laterocaval, retrocaval, and intermediate*.

– **Posteriorly**, it is related to:

- the bodies of the lumbar vertebrae from L4 to L1,
- the psoas major muscle,
- the right sympathetic trunk,
- the right crus of the diaphragm,
- the medial part of the right adrenal gland,
- the right lumbar, renal, middle suprarenal, and inferior phrenic arteries.

– **Anteriorly**, from bottom to top, it is related to:

- the origin of the right common iliac artery,

- the root of the mesentery and its vessels,
- the right testicular or ovarian artery,
- the horizontal part of the duodenum,
- the head of the pancreas,
- the omental vestibule, which separates it from the superior part of the duodenum and the hepatoduodenal ligament,
- and the liver, which creates a groove separating the right and caudate lobes.

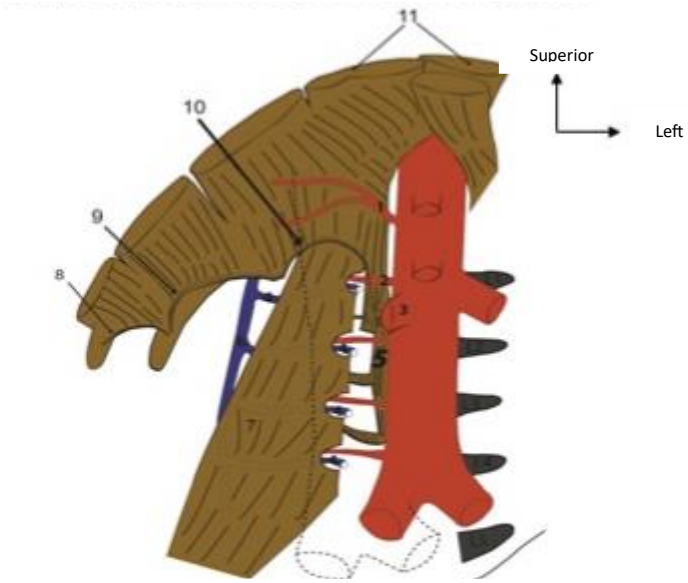
– **On its left side**, it is related to:

- the abdominal aorta,
- the right crus of the diaphragm,
- and the caudate lobe of the liver.

– **On its right side**, it is related to:

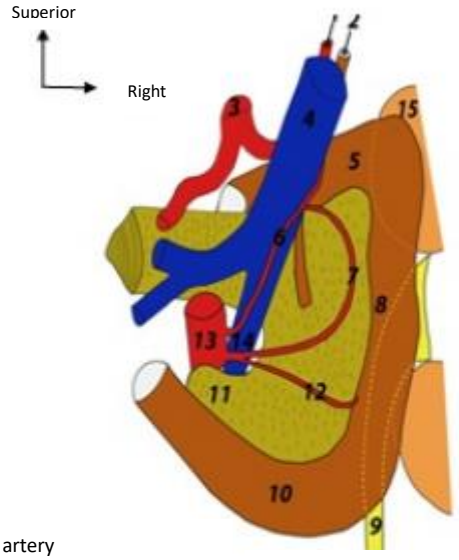
- the ascending colon,
- the medial border of the right kidney,
- and the right ureter.

Relations in the abdomen: parietal and vascular relations.



1- Right inferior diaphragmatic artery
2- Lumbar artery
3- Right renal artery
4- Right lumbar arteries
5- Right diaphragmatic pillar
6- Ascending lumbar vein
7- Right psoas major muscle
8- First arcade of Senac
9- Arcade of the quadratus lomborum
10- Arcade of the psoas muscle
11- Right pillar of the diaphragm

Anterior relations in the abdomen: posterior view of the duodeno-pancreatic block



1- Hepatic artery
2- Common bile duct
3- Celiac trunk
4- Portal vein
5- First duodenum
6- Right hepatic artery
7- Posterior duodeno-pancreatic vascular arcade
8- Second duodenum
9- Right ureter
10- Third duodenum
11- Pancreatic uncinate process
12- Anterior duodeno-pancreatic vascular arcade
13- Superior mesenteric artery
14- Inferior mesenteric artery
15- Right kidney

2. Thoracic relations:

The inferior vena cava has a short thoracic course of approximately 3 cm, entirely covered by the fibrous pericardium.

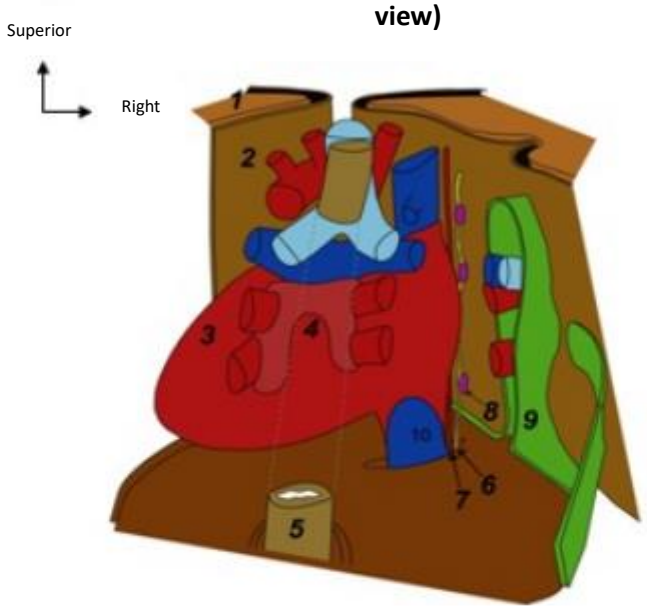
Through the pericardium, it is related to the following structures:

- **Anteriorly**:
    - to the inferior wall of the right atrium.
- **Posteriorly**:
    - on the right, to the triangular ligament of the right lung,
    - on the left, to the oesophagus.
- **Medially**:

- to the pericardiacophrenic space, which is bounded by the pericardium, the diaphragm, the inferior vena cava, and the anterior phrenicopericardial ligament.

- **Laterally**:
  - to the right phrenic nerve, accompanied by the right superior diaphragmatic vessels and lateral pericardial lymph nodes,
  - to the right phrenicopericardial ligament,
  - to the right mediastinal pleura and the right lung.

Relations of the IVC in the thorax (posterior view)



1- Left lung
2- Left pleura
3- Left surface of the heart
4- Haller's sinus
5- Esophagus
6- Right phrenic nerve
7- Right superior diaphragmatic artery
8- Lymphatic chain
9- Triangular ligament of the lung
10- Inferior vena cava

3. Relations at the level of the diaphragm:

The inferior vena cava is tightly adherent to the margins of the diaphragmatic foramen through which it passes — the caval opening of the diaphragm.

IV – COLLATERAL BRANCHES:

The inferior vena cava receives:

1. Lumbar veins:

They originate near the intervertebral foramina by the union of a dorsospinal branch and an anterior (abdominal) branch. They run transversely, passing above the lumbar arteries, and drain into the inferior vena cava.

2. Renal veins:

- These veins drain the right and left kidneys, forming two large trunks that run slightly obliquely toward the inferior vena cava.
- They lie anterior to the arterial plane.
- The left renal vein is longer than the right and passes anterior to the aorta and the superior mesenteric artery.

3. Middle suprarenal veins:

- These veins drain the adrenal glands.
- The right suprarenal vein empties directly into the inferior vena cava, whereas the left suprarenal vein drains into the left renal vein.

4. Gonadal veins (spermatic or uterine-ovarian veins):

The gonadal veins originate from the testicles and ovaries and ascend laterally to the inferior vena cava.

- The left gonadal vein drains into the left renal vein.
- The right gonadal vein drains directly into the inferior vena cava.

5. Hepatic veins (or supra-hepatic veins):

- The hepatic veins transport blood from the liver to the inferior vena cava.
- They are distinguished by two major hepatic veins (right and left) and smaller hepatic veins, which open into the inferior vena cava just below the larger veins.
- The extra-parenchymal course of the hepatic veins is typically very short.

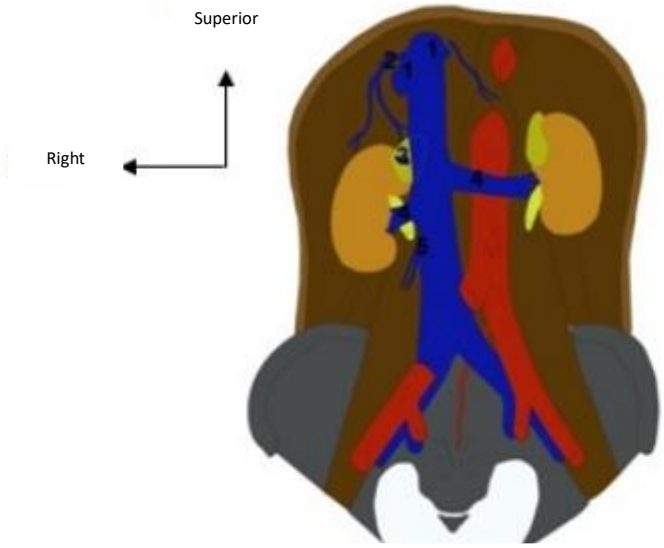
Note: *Obstruction of the suprarenal veins leads to Budd-Chiari syndrome.*

6. Inferior diaphragmatic veins:

The inferior diaphragmatic veins are drained into the inferior vena cava near its diaphragmatic orifice. In most cases, the left inferior diaphragmatic vein is larger than the right one.

Note: *In cases of total vascular exclusion of the liver, it may be necessary, before performing suprahepatic caval clamping, to control and ligate the left inferior diaphragmatic vein.*

Collateral branches of the inferior vena cava (excluding the lumbar veins)



1- Suprahepatic veins
2- Inferior diaphragmatic vein
3- Right main suprarenal vein
4- Renal veins
5- Spermatic or uterine-ovarian veins

V - ANASTOMOSES:

1. Porto-caval anastomoses:

Porto-caval anastomoses can be schematized into five systems:

- **Cardia region anastomoses**, vascularized in part by the **inferior diaphragmatic arteries**.

Note: *These anastomoses form* ***cardio-esophageal varices*** *in cases of* ***portal hypertension****.*

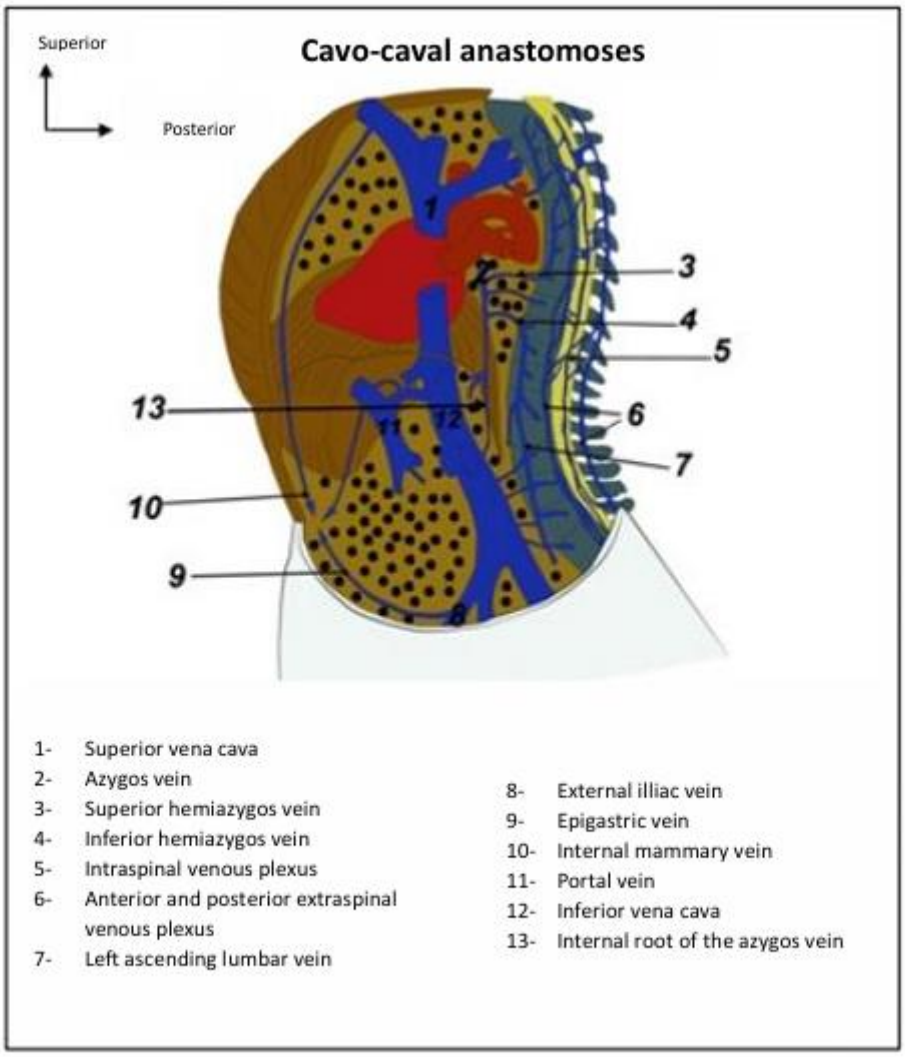
- **Umbilical region anastomoses** with the **para-umbilical veins** of the **round ligament**.
- **Rectal anastomoses** with the **superior hemorrhoidal veins**.
- **Peritoneo-parietal anastomoses**.
- **Porto-suprahepatic anastomoses** through the abnormal persistence of the **Arantius canal**, which directly connects the **portal vein** to the **inferior vena cava**.

2. Cavo-caval anastomoses:

Cavo-caval anastomoses form four longitudinal systems:

- **Anterior parietal system**, formed by the **epigastric veins** and **internal mammary veins**.
- **Lombo-azygos system**, formed by the **ascending lumbar veins**, the **great azygos vein** on the right, and the **inferior hemiazygos vein** on the left.
- **Systems of the extra and intra-rachidian plexuses.**

Note: *These anastomoses allow the ligation of the* ***inferior vena cava*** *below the* ***renal veins****, restoring circulation in case of obstruction.*



VI – CLINICAL APPLICATIONS:

Renal vein junction :

This is an important region of the body located at the level of L1. Two segments of the inferior vena cava should be distinguished. In its sub-renal segment, the vein serves as a drainage for the lower limbs and the pelvic cavity, with a flow rate of 1.5 L/min. At the level of the carrefour, its flow rate increases. The flow of the renal veins is visible on an X-ray with opacification of the inferior vena cava.

The left renal vein plays a crucial physiological role since, in addition to draining blood from the left kidney, it also drains the left gonadal gland and, importantly, the left adrenal gland, carrying its hormones.

❖ Variants of the inferior vena cava:

- The incidence of such variants is rare, and their clinical impact is generally low. However, understanding them allows for the correction of certain diagnostic errors and helps in better planning of interventional procedures.
- The most common anomalies affect the lower segment of the vein, which is sometimes duplicated: a left inferior vena cava.
- Much more rarely, the anomalies affect the upper segment, the retro-hepatic part of the inferior vena cava, which may present:
  - **Atresia**,
  - **Absence**, with the infra-renal segment, either single or double, usually passing through the diaphragm alongside the aorta and draining into the superior vena cava, which itself may sometimes be duplicated.

❖ Inferior vena cava thrombosis:

The wall of the inferior vena cava consists of an endothelium and a thin longitudinal layer of smooth muscle fibers, forming a media that is much thinner than in arteries. This allows the vein to hold a large volume of blood at low pressure.

In the veins of the pelvic limbs, inflammatory conditions or surgical interventions can promote the formation of clots that obstruct the venous lumen: phlebitis or thrombosis. These clots can detach from the vein wall and become lodged higher up in the inferior vena cava, resulting in inferior vena cava thrombosis.

VII – SURGICAL APPROACHES

❖ Median xipho-pubic laparotomy:

This approach provides an excellent view of the inferior vena cava from its origin to the point where the renal veins join. It is performed from the xiphoid process to below the umbilicus, with the distance from the pubis depending on whether a procedure is needed on the sub-renal segment of the inferior vena cava.

❖ Bi-subcostal laparotomy:

The bi-subcostal incision provides the most suitable and safest access to the subhepatic segment and the retro- and supra-hepatic segments of the inferior vena cava. If associated

hepatectomy is planned, this incision allows for nearly total resection of the liver. The incision is made two finger widths below the costal margin and can be extended with a median incision up to the xiphoid process, which may need to be resected.

- **Thoraco-abdominal laparotomy**:

A thoraco-abdominal approach may be required when there is a very large tumor in the right liver, involving posterior and superior regions, or for a tumor invading the diaphragm near the opening of the inferior vena cava. This access is necessary to mobilize the liver and reach the retrohepatic and suprahepatic segments of the inferior vena cava.

- **Median sternotomy**:

This may be indicated when it is necessary to control the intra-pericardial inferior vena cava. The median sternotomy is performed to provide access to this region for surgical intervention.

VIII - CONCLUSION:

The inferior vena cava is a large vein that carries deoxygenated blood from the lower half of the body to the right atrium of the heart. The management of its various pathologies requires a thorough understanding of its anatomy.