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THORACIC AORTA

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PLAN:

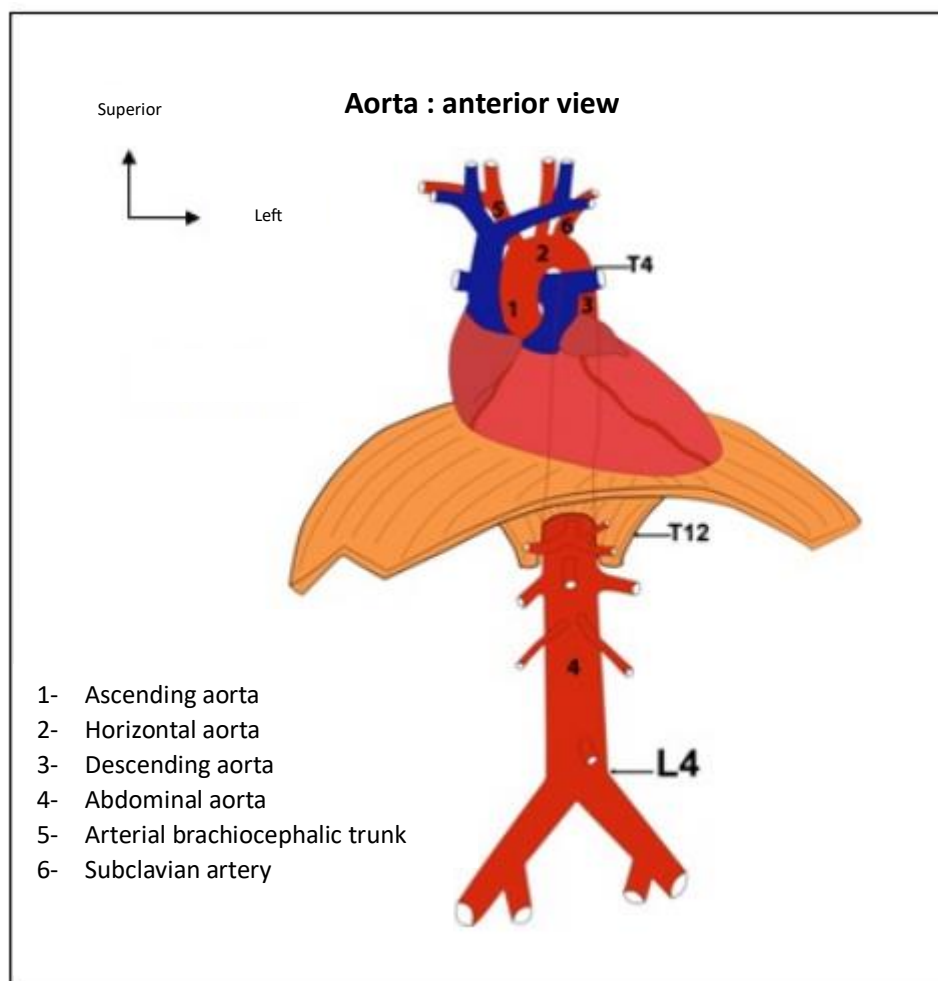
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I – INTRODUCTION:

- Along its mediastinal course, the thoracic aorta displays three distinct segments: ascending, horizontal, and descending.
- It arises from the left ventricle and continues as the abdominal aorta at the level of the inferior border of T12.

Relevance of the topic:

- ***Pathological:*** The thoracic aorta can be affected by numerous conditions, notably aneurysm and aortic dissection. It may also present congenital malformations, the most frequent being coarctation of the aorta, which leads to arterial hypertension and can result in serious, potentially fatal, complications.
- ***Therapeutic:*** The management of thoracic aortic diseases represents one of the major challenges in thoracic surgery.



II – DESCRIPTIVE ANATOMY:

1. Origine – course – termination :

The thoracic aorta follows the aortic orifice of the left ventricle and is composed of three segments:

- **Ascending aorta:**

- The ascending aorta is entirely intrapericardial. It courses upwards, forwards, and to the right, forming a leftward concavity.
- It projects posteriorly to the first left sternocostal joint.

- **Horizontal aorta:**

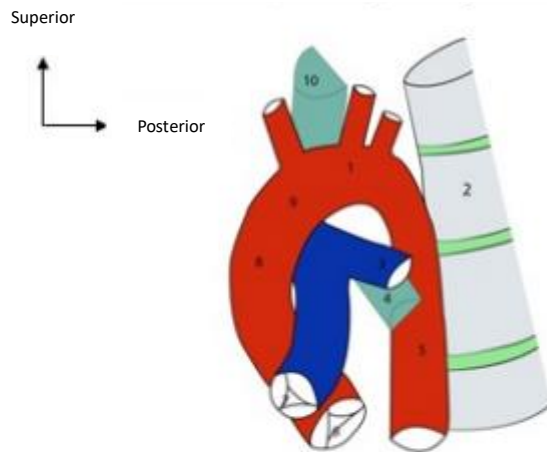
The horizontal aorta is extrapericardial. It extends from the origin of the brachiocephalic trunk to the origin of the left subclavian artery. It is directed backwards and to the left, and presents a double concavity: an inferior concavity and a rightward concavity.

→ **The aortic arch** corresponds to the combined structure of the ascending and horizontal segments.

- **Descending thoracic aorta:**

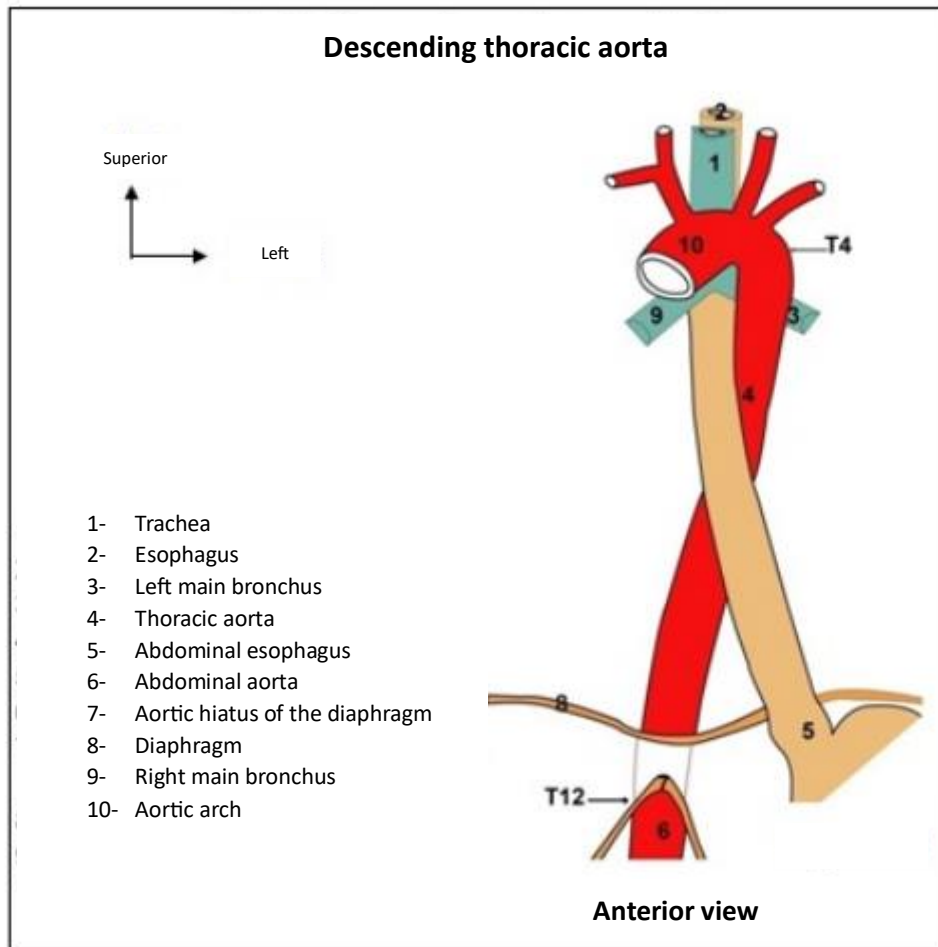
- It continues from the aortic arch, distal to the origin of the left subclavian artery, opposite the left side of T4.
- It runs almost vertically, in close contact with the vertebral column, following its curvature (downwards and to the right).
- After crossing the diaphragm, it continues as the abdominal aorta at the level of T12.

Aortic arch : origin – course – termination



Lateral view

- 1- Horizontal segment of the aortic arch
- 2- 4th thoracic vertebra
- 3- Left main bronchus
- 4- Thoracic aorta
- 5- Aortic semilunar valve
- 6- Pulmonary semilunar valve
- 7- Vertical segment of the aortic arch
- 8- Position of the great sinus at the junction angle of the two segments
- 9- Trachea



2. Location :

- **Ascending aorta:** Located in the anterior mediastinum.

Note: *Surgical access via sternotomy.*

- **Horizontal aorta:** Located in the middle mediastinum, it crosses over the left pulmonary pedicle from front to back.

Note: *Surgical access is less straightforward.*

- **Descending thoracic aorta:** Descends through the posterior mediastinum, then continues into the posterior inframediastinal space.

Note: *Surgical access via left postero-lateral thoracotomy.*

3. Dimensions :

❖ **Length :**

- **Ascending aorta:** 6 to 8 cm.
- **Horizontal aorta:** 4 to 5 cm.
- **Descending aorta:** 20 to 25 cm.

❖ **Diameter :**

- The diameter measures between 25 and 30 mm at the level of the ascending aorta. It decreases after the origin of the major cephalobrachial trunks, stabilising at 18–20 mm at the level of the descending aorta.
- Three particular areas can be distinguished:
 - **Origin:** Characterised by three dilatations opposite the semilunar (sigmoid) aortic valves, known as the aortic sinuses (or sinuses of Valsalva).

Note: *At the end of systole, when the ejected blood tends to reflux towards the left ventricle, these sinuses inflate like reversed parachutes to close the aortic valve and prevent any backflow of blood.*

- **Grand sinus:** This is another dilatation located at the junction between the ascending and horizontal segments of the aorta. It becomes more distinct in elderly individuals.

Note: *This is where the maximum pressure during systole is exerted, which can lead to aneurysm rupture.*

- **Isthmus (Stahel):** Located at the junction between the horizontal and descending aorta, this is a slightly narrower area.

Note:

- ✓ *Post-traumatic rupture, particularly in cases of significant deceleration, is the main acquired pathology of the aortic isthmus.*
- ✓ *It can also be the site of a congenital abnormality: coarctation of the aorta.*

4. Structure:

The thoracic aorta is an elastic-type artery with a thick wall measuring approximately 1.5 mm, composed of three layers:

- **Inner layer (intima):** Endothelial in nature.
- **Middle layer (media):** Thick, accounting for 90% of the wall's thickness.

Note: *Aortic dissection is a haemorrhagic infiltration of the media, causing a longitudinal cleavage of the aortic wall. Clinically, it presents with severe, stabbing pain.*

- **Outer layer (adventitia):** Composed of connective tissue, containing the vasa vasorum (small vessels of the adventitia) and nerve fibres.

III – ANATOMICAL RELATIONS:

1. Ascending aorta :

a. Intra-pericardial relations :

The ascending aorta is enclosed within the same epicardial sheath as the pulmonary trunk. The pulmonary trunk initially lies anterior to the aorta, then curves to the left and upwards. Its anatomical relations are as follows:

- **Anteriorly:** In contact with the right auricle.
- **Posteriorly:** In relation to the transverse sinus of Theile.

- **To the right:**
 - At the right opening of the transverse sinus,
 - And the superior vena cava.

b. Extra-pericardial relations :

Through the fibrous pericardium, the ascending aorta is related to:

- **Anteriorly:**
 - The thymus in children,
 - The sternum,
 - The mediastinal pleura and the lungs.
- **Posteriorly :** The carina.
- **To the right:**
 - The supra-pericardial superior vena cava,
 - The right phrenic nerve,
 - And the superior phrenic vessels.
- **To the left:**
 - The cardiac plexus,
 - And Wrisberg's cardiac ganglia.

2. Horizontal aorta :

The horizontal aorta is extra-pericardial and presents four surfaces:

- The antero-left surface,
- The postero-right surface,
- The superior surface,
- And the inferior surface.

→ Antero-left surface:

It is crossed from front to back by:

- The left phrenic nerve,
- The superior cervical cardiac branches,
- The left vagus nerve,
- The left superior intercostal vein runs along this surface, posterior to the phrenic nerve.

→ Superior surface:

It is crossed by a venous plane (the left brachiocephalic vein), which defines two anatomical spaces:

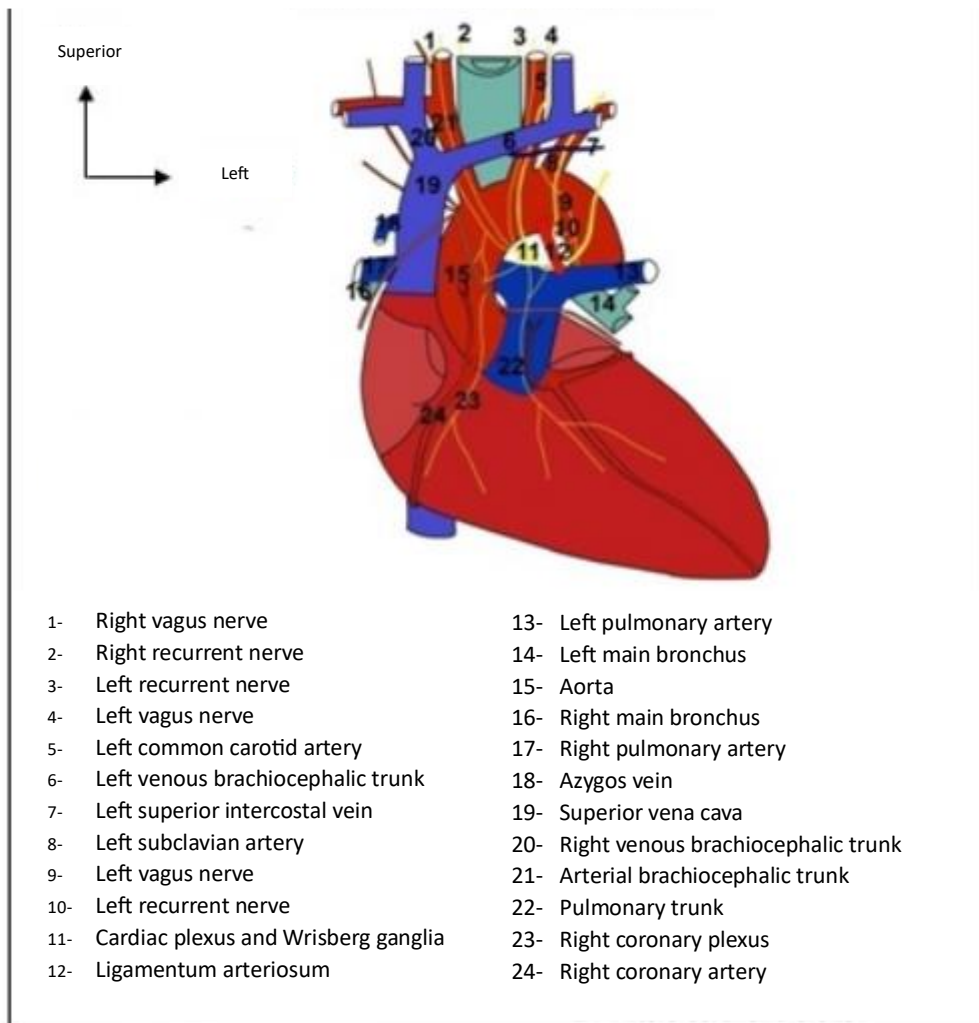
- A pre-tracheal vascular lozenge, bounded by :
 - Superiorly: the left brachiocephalic vein,
 - To the left: the left common carotid artery,
 - To the right: the brachiocephalic trunk,
 - Inferiorly: the second segment of the aorta.
 - This space contains the middle thyroid artery and the lower portion of the thymus.
- And a left latero-tracheal vascular quadrilateral (described by Bourguery), bounded by :
 - Superiorly: the left superior intercostal vein joining the left brachiocephalic vein,
 - To the right: the left common carotid artery,
 - To the left: the left subclavian artery,
 - Inferiorly: the second segment of the aorta.
 - Within this quadrilateral cross the left phrenic nerve and the left vagus nerve.

→ Inferior surface:

It is related to:

- The bifurcation of the pulmonary trunk,
- The left main bronchus and the cardiac lymph nodes,
- It is connected to the left pulmonary artery by the ligamentum arteriosum,
- And it is looped around by the left recurrent laryngeal nerve.

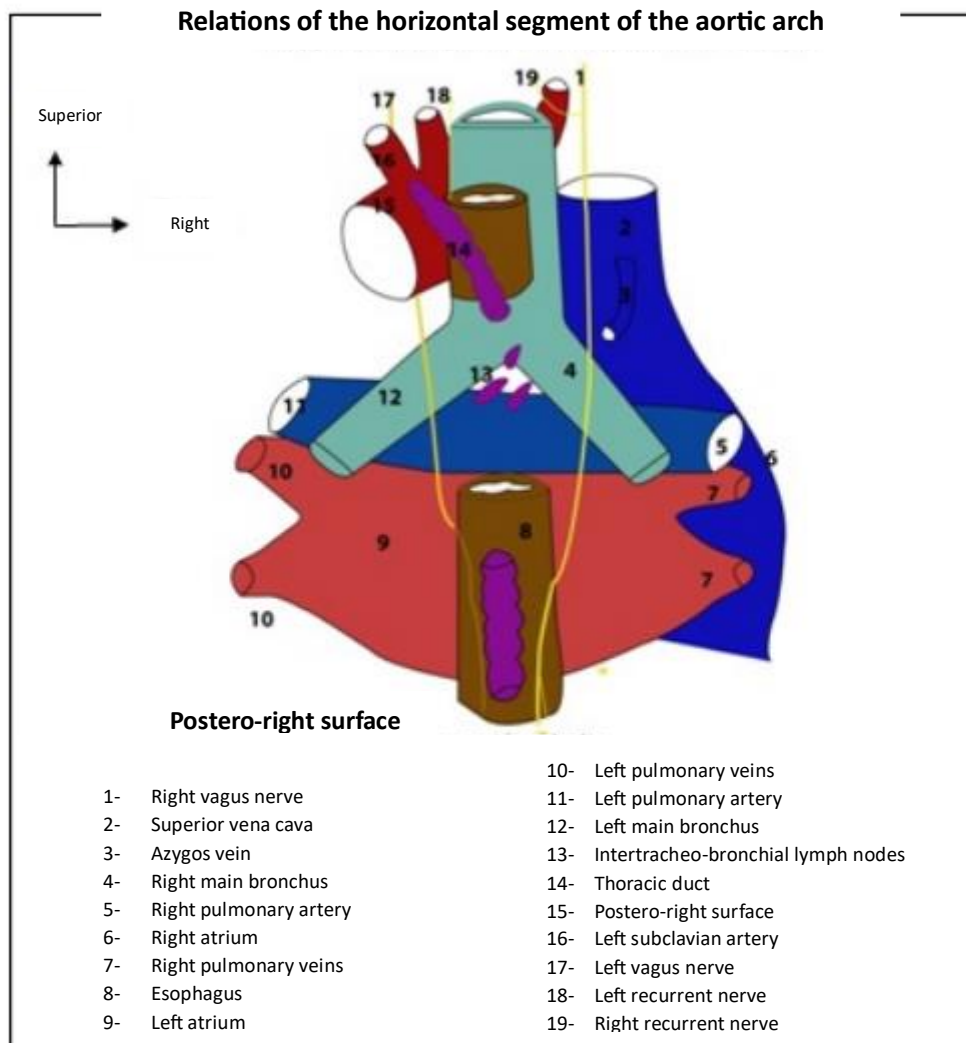
Relations of the horizontal segment of the aortic arch : superior and inferior surfaces



→ Postero-right surface:

It is related from front to back to:

- The trachea,
- The left recurrent laryngeal nerve,
- The thoracic esophagus,
- And the thoracic duct.

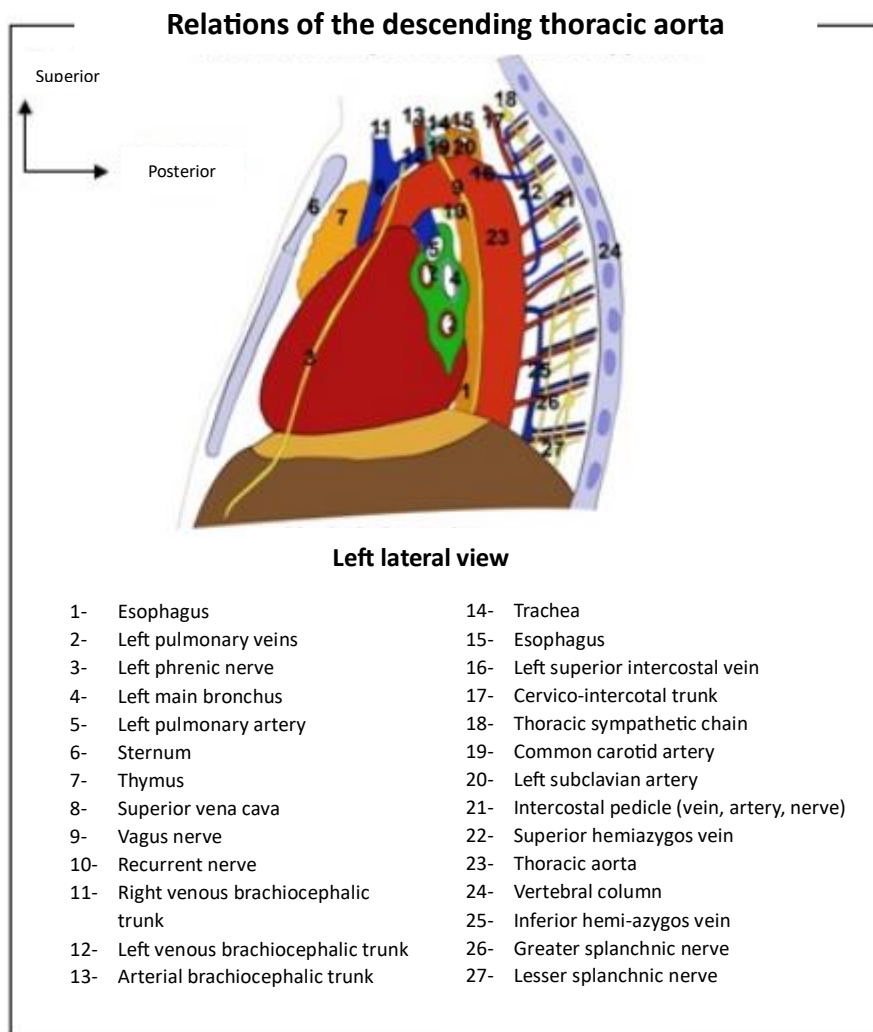


2. Descending aorta:

The descending aorta is related:

- **Anteriorly (from top to bottom):**
 - The left pulmonary pedicle,
 - The left vagus nerve,
 - And the thoracic esophagus.
- **Posteriorly:**
 - The thoracic duct inferiorly,
 - The horizontal portion of the hemi-azygos veins,
 - The left greater splanchnic nerve,
 - And the thoracic spine.

- **To the left:** The mediastinal pleura and the left lung.
- **To the right:**
 - The lateral surface of the thoracic spine,
 - The thoracic esophagus,
 - The thoracic duct,
 - And the azygos vein.



IV – COLLATERAL BRANCHES:

1. Ascending aorta:

The ascending aorta gives rise to the two coronary arteries:

❖ Left coronary artery:

It originates from the posterior-left aspect of the aorta, just behind the pulmonary artery. It is short (approximately 10 mm) and gives rise to:

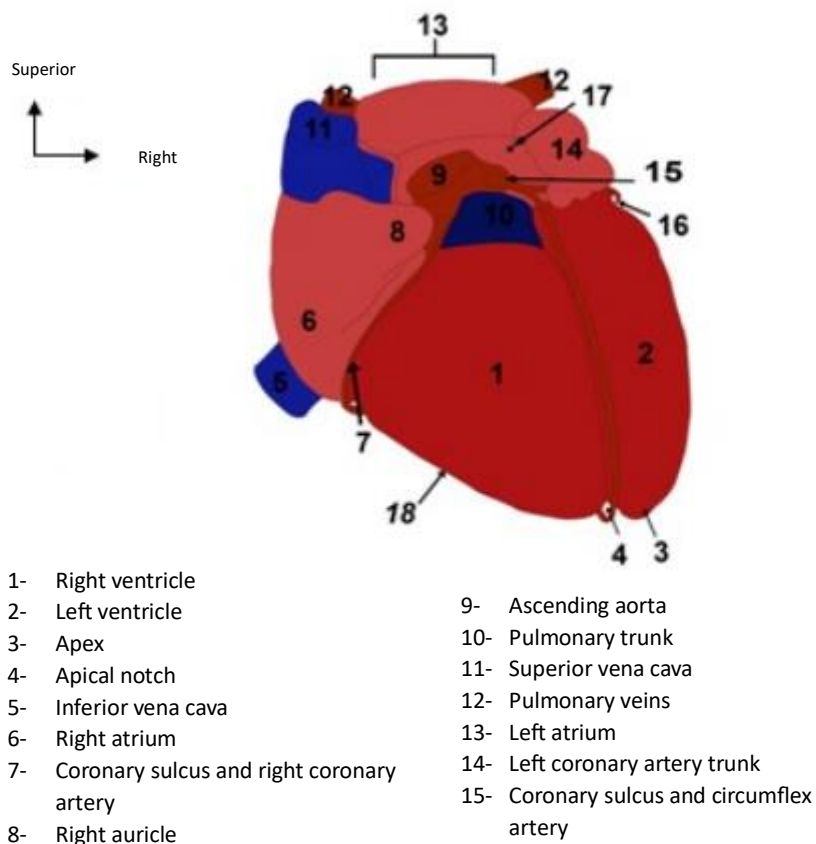
- **The circumflex artery:** It runs in the left atrioventricular sulcus, curves around the left border of the heart, and ends just before the crossing of the sulci, on the inferior surface of the left ventricle.
- **The anterior interventricular artery:** It runs in the anterior interventricular sulcus, curves around the apex of the heart, and ends in the posterior interventricular sulcus.

❖ Right coronary artery :

It originates clearly anteriorly at the level of the sinus of Valsalva, but is concealed at its origin by the right auricle. It has three segments:

- The first is oblique, descending, anterior, and to the right, reaching the anterior atrioventricular sulcus.
- The second is vertical, running along the entire length of this sulcus.
- The third segment, after curving around the right border of the heart, travels along the inferior part of the atrioventricular sulcus.

Collateral branches of the ascending aorta : antero-right view of the heart



2. Horizontal aorta:

The horizontal aorta gives rise to three major collateral arteries:

❖ The brachiocephalic trunk:

It originates from the superior aspect of the aortic arch. It ascends obliquely upwards, to the right, and slightly posteriorly, before becoming right laterotracheal.

After traveling about 3 cm, it reaches the right sternoclavicular joint and bifurcates into two branches:

- The right subclavian artery,
- And the right common carotid artery.

❖ The left common (primitive) carotid artery:

It arises from the superior aspect of the horizontal aorta, behind the left brachiocephalic venous trunk. It ascends obliquely upwards, to the left, and posteriorly, before positioning itself on the left lateral side of the trachea.

❖ The left subclavian artery:

It originates from the superior aspect of the horizontal aorta, posterior to the left common carotid artery. It ascends almost vertically upwards to the base of the neck.

A few accessory branches may arise from the horizontal segment:

- The middle thyroid artery,
- The bronchial arteries,
- And arteries destined for the esophagus.

3. Descending aorta:

The collateral arteries of the descending thoracic aorta are divided into two groups: visceral arteries and parietal arteries:

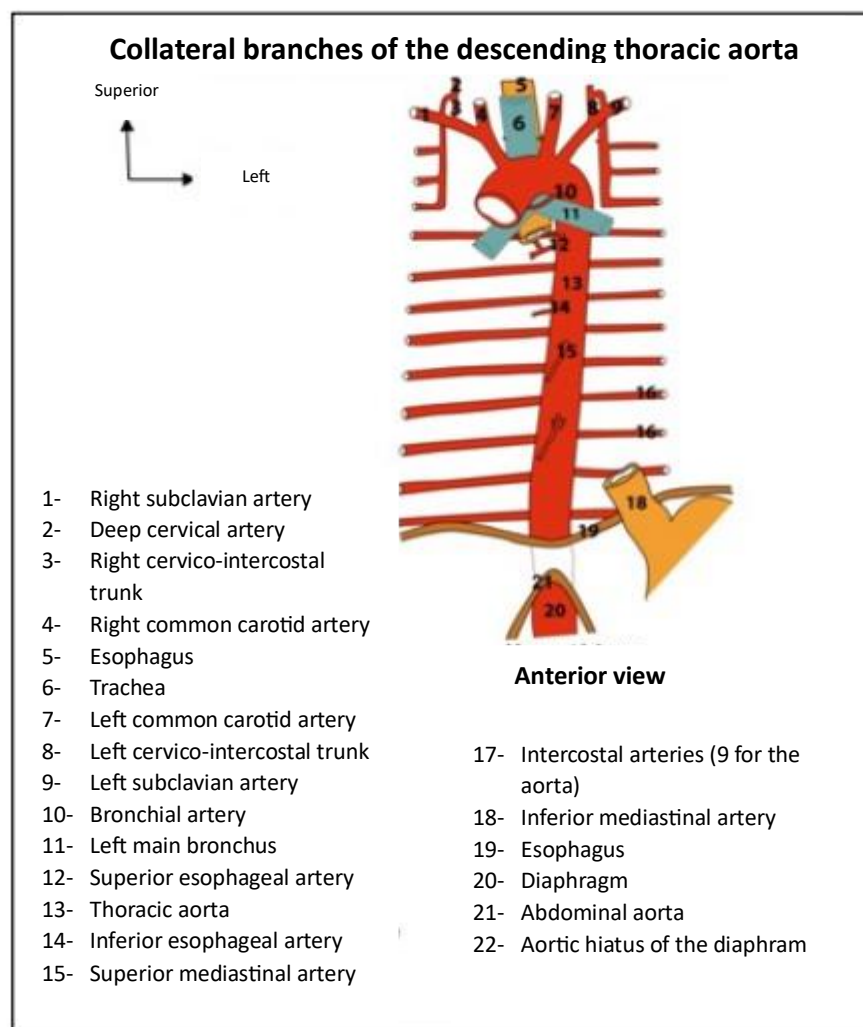
❖ Visceral branches:

- **Bronchial arteries:** There are two of them. They arise from the lateral aspects of the upper part of the descending aorta and reach the posterior surfaces of the left and right main bronchi. They terminate in the pulmonary parenchyma.
- **Esophageal arteries:** There are between two and four of them. They originate from the anterior surface of the aorta at varying levels. They supply the esophagus, along with other anastomotic arteries from the lower diaphragmatic arteries, gastric coronaries, and bronchial arteries.

- **Mediastinal arteries:** These originate from the anterior surface of the aorta and supply the pleura, pericardium, and lymph nodes.

❖ **Parietal branches:**

- The **superior phrenic arteries**,
- The last **nine intercostal arteries:** They arise from the posterior surface of the aorta. Once they reach the posterior extremity of the intercostal space, they bifurcate into two terminal branches:
 - The dorsospinal artery,
 - And the true intercostal artery.



VI – CLINICAL APPLICATIONS:

Aortic aneurysm of the ascending aorta :

- When the left ventricle contracts, the distal part of the ascending aorta undergoes a strong blood surge. Since its wall is not reinforced by the fibrous pericardium, an aneurysm (localized dilation) may develop at this site.
- The aneurysm appears on a chest X-ray as an enlarged silhouette of the ascending aorta. Individuals affected by this condition typically complain of chest pain that radiates to the back.
- The treatment for an aortic aneurysm exceeding 5 cm in diameter is surgical, in order to prevent complications that can be fatal. This treatment involves replacing the pathological aorta with a vascular prosthesis anchored to the aneurysmal wall.

V– SURGICAL APPROACH ROUTES:

1. Anterior approach routes:

Whether through anterior thoracotomy, median sternotomy, or a combination of both types of incisions, these approaches provide excellent access to the ascending aorta and the entire horizontal aorta. However, the limitation of these approaches is their restriction towards the posterior part. Access to the descending thoracic aorta is highly limited.

- **Median sternotomy:**

This allows excellent access to the aortic arch up to the aortic isthmus.

- **Median sternotomy combined with an anterolateral thoracotomy:**

The anterior thoracotomy is typically performed in the 5th or 6th intercostal space and starts from the left border of the sternum. The pectoralis major muscle is divided, as well as the anterior part of the serratus anterior muscle. It is important to take care not to damage the long thoracic nerve during this procedure.

2. Left postolateral thoracotomy :

This is the reference approach for accessing the descending thoracic aorta. It is the only approach that provides direct exposure of the entire descending thoracic aorta in a single step.

The level of the thoracotomy depends on the location of the aortic lesions:

- **4th intercostal space:** for the isthmic portion of the descending thoracic aorta,
- **6th intercostal space:** for the middle portion of the descending thoracic aorta,
- **7th or 8th intercostal space:** for the lower portion of the descending thoracic aorta.

After incision of the subcutaneous tissue, the superficial muscular plane is made up of the latissimus dorsi muscle. This muscle is cut across its fibers along its entire extent. The aponeurosis of the serratus anterior muscle is then detached anteriorly and inferiorly along its anteroposterior edge. The intercostal muscles are divided at the upper border of the lower rib in the chosen space, avoiding the intercostal nerve. After excluding the left lung, opening the endothoracic fascia allows access to the left pleural cavity.

The aorta is approached directly by incising the mediastinal pleura after displacing the lung anteriorly.

VI– CONCLUSION:

Pathologies of the thoracic aorta are considered severe, with a very high surgical risk.

Anatomical study allows for a better interpretation of clinical signs, as well as paraclinical tests, resulting in a more accurate diagnostic and therapeutic approach.