MEDICAL EDUCATION RESOURCE

Superior Vena Cava, Aorta and Pulmonary Trunk

Introduction

- The **superior vena cava (SVC)** returns **deoxygenated blood** from the **head and neck, upper limbs, and thorax** to the **right atrium**.
- The **aorta** and **pulmonary trunk** are the two major **arterial outflow tracts** of the heart, both derived embryologically from a **single truncus arteriosus**.
- These great vessels lie closely related at the root of the heart

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Superior Vena Cava (SVC)

Formation

- Formed by the union of **right and left brachiocephalic (innominate) veins** behind the **lower border of the first right costal cartilage**, near the sternum.
- Each brachiocephalic vein = internal jugular + subclavian vein

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Course

- About **7 cm long**.
- Begins behind the lower border of the 1st right costal cartilage, pierces the pericardium opposite the 2nd, and opens into the **right atrium** behind the **3rd right costal cartilage**.
- **No valves** present

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Relations

- **Anterior:** Chest wall, internal thoracic vessels, right lung and pleura.
- **Posterior:** Trachea, right vagus nerve, root of right lung.
- **Medial:** Ascending aorta, brachiocephalic artery.
- **Lateral:** Right phrenic nerve, right pleura and lung

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Tributaries

- **Azygos vein** (arches over right lung root).
- **Small mediastinal and pericardial veins.**

Aorta

Parts

1. **Ascending Aorta**
2. **Arch of Aorta**
3. **Descending Thoracic Aorta**

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Ascending Aorta

- **Origin:** Upper end of left ventricle, enclosed in pericardium.
- **Length:** ~ 5 cm.
- **Course:** Upward, forward, to the right ? becomes **arch of aorta** at upper border of 2nd right costal cartilage.
- **Relations:**
  - *Anterior:* Sternum, right lung and pleura, RV infundibulum, pulmonary trunk, right auricle.
  - *Posterior:* Transverse pericardial sinus, LA, right pulmonary artery, right bronchus.
  - *Right side:* SVC, right atrium.
  - *Left side:* Pulmonary trunk (above), LA (below).
- **Branches:**
  - *Right coronary artery* — from anterior aortic sinus.
  - *Left coronary artery* — from left posterior aortic sinus

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Arch of Aorta

- **Course:** Upward, backward, then downward behind left bronchus to continue as descending aorta.
- **Branches (“ABC’S” Mnemonic):**
  - **A** – Aortic arch
  - **B** – Brachiocephalic trunk
  - **C** – Left Common Carotid
  - **S** – Left Subclavian

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Descending Thoracic Aorta

- Lies in posterior mediastinum; gives **posterior intercostal**, **bronchial**, **oesophageal**, **pericardial**, **superior phrenic arteries**.

Pulmonary Trunk

- **Origin:** From **right ventricle**.

- **Course:** Ascends obliquely upward, backward, left; divides into **right and left pulmonary arteries** carrying **deoxygenated blood to lungs**.
- **Relations with Aorta (Triple Relationship):**
  - At the heart base ? pulmonary trunk lies **anterior** to ascending aorta.
  - At upper heart border ? lies **left** of aorta.
  - Above that ? right pulmonary artery lies **posterior** to ascending aorta

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- **Development:** Pulmonary trunk + ascending aorta both arise from **truncus arteriosus**.

Development

- **Superior Vena Cava:** Upper half from *caudal part of right anterior cardinal vein*.
- **Arch of Aorta:** Left aortic sac + 4th aortic arch + left dorsal aorta.
- **Pulmonary Trunk:** Derived from *truncus arteriosus*

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Clinical Anatomy

- **SVC Obstruction above azygos opening:** Venous return via azygos vein ? dilated chest veins up to costal margin.
- **SVC Obstruction below azygos opening:** Blood drains to IVC through thoraco-epigastric veins ? veins dilated on chest and abdomen.
- **Mediastinal syndrome:** Early signs = SVC obstruction (supraclavicular venous engorgement)

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- **Patent Ductus Arteriosus (PDA):** Persistent connection between left pulmonary artery and aortic arch ? continuous “machinery murmur” at 2nd left intercostal space; treated surgically

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Facts to Remember

- **SVC:** Second largest vein of body.
- **Aorta:** Largest elastic artery; transitions to muscular type in branches.
- **Pulmonary trunk:** Arises from right ventricle; divides into two arteries carrying deoxygenated blood.
- **Aorta & Pulmonary trunk:** Common origin – *truncus arteriosus*.

- **Triple relation:** Pulmonary trunk (anterior) ? left of aorta ? right pulmonary artery posterior

AORTA

- The **aorta** is the **great arterial trunk** of the systemic circulation.
- It carries **oxygenated blood from the left ventricle** to all parts of the body.
- It is divided into three parts:
    1. **Ascending aorta**
    2. **Arch of aorta**
    3. **Descending thoracic aorta**

ASCENDING AORTA

Origin and Course

- Begins from the **upper end of the left ventricle** behind the **left half of the sternum** at the **lower border of the 3rd costal cartilage**.
- About **5 cm long**, enclosed within the **pericardium**.
- It runs **upward, forward, and to the right**, ending at the **upper border of the 2nd right costal cartilage** to continue as the **arch of aorta**

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Aortic Sinuses

- At its root, the wall of the aorta shows **three dilatations** — the **aortic sinuses**:
  - **Anterior sinus** ? gives rise to **Right Coronary Artery**
  - **Left posterior sinus** ? gives rise to **Left Coronary Artery**
  - **Right posterior sinus** ? no branch

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Relations

- **Anterior:** Sternum, right lung and pleura, infundibulum of right ventricle, pulmonary trunk, right auricle.
- **Posterior:** Transverse sinus of pericardium, left atrium, right pulmonary artery, right bronchus.
- **Right side:** Superior vena cava and right atrium.
- **Left side:** Pulmonary trunk (above) and left atrium (below).

Branches

- **Right coronary artery** from anterior aortic sinus.
- **Left coronary artery** from left posterior aortic sinus.

ARCH OF AORTA

Extent and Course

- Continuation of the ascending aorta; lies in **superior mediastinum** behind **manubrium sterni**.
- Begins behind **upper border of 2nd right sternocostal joint**, arches **upward, backward, and to the left** over the **root of left lung**, ending at the **lower border of 4th thoracic vertebra** where it continues as **descending thoracic aorta**

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Relations

Anterior and to the Left:

- Four nerves (from before backward):
  1. Left phrenic nerve
  2. Lower cervical cardiac branch of left vagus
  3. Superior cervical cardiac branch of left sympathetic chain
  4. Left vagus nerve
- Left superior intercostal vein
- Left pleura and lung
- Remains of thymus

Posterior and to the Right:

- Trachea, deep cardiac plexus, tracheobronchial lymph nodes
- Esophagus
- Left recurrent laryngeal nerve
- Thoracic duct
- Vertebral column

Superior:

- Branches of arch (brachiocephalic, left common carotid, left subclavian) — all crossed by **left brachiocephalic vein**.

Inferior:

- Bifurcation of pulmonary trunk, left bronchus, ligamentum arteriosum, and superficial cardiac plexus.

Branches

1. **Brachiocephalic artery** ? divides into right common carotid and right subclavian.
2. **Left common carotid artery**
3. **Left subclavian artery**

Mnemonic: *"ABC's of Aortic Arch"*
A – Arch of aorta
B – Brachiocephalic trunk
C – Left Common carotid artery

DESCENDING THORACIC AORTA

Extent

- Begins at **lower border of T4 vertebra** and ends at **T12**, where it passes through **aortic opening of diaphragm** to become the **abdominal aorta**

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Relations

- **Anterior:** Root of left lung, pericardium, esophagus.
- **Posterior:** Vertebral column, hemiazygos veins.
- **Right side:** Esophagus, thoracic duct, azygos vein.
- **Left side:** Left pleura and lung.

Branches

- **Visceral:**
  - Bronchial arteries (one right, two left)
  - Esophageal arteries
  - Pericardial branches
- **Parietal:**

- Posterior intercostal arteries (3rd–11th spaces)
- Subcostal arteries
- Superior phrenic arteries

CLINICAL ANATOMY

- **Aortic Knuckle:**
  - Seen on chest X-ray as a **projection beyond the left mediastinal margin** — more prominent in elderly individuals

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- **Coarctation of Aorta:**
  - Congenital **narrowing opposite or just distal to the ductus arteriosus**.
  - Causes **rib notching** due to enlarged intercostal arteries forming collateral circulation.
- **Ductus Arteriosus & Ligamentum Arteriosum:**
  - In fetal life, ductus arteriosus connects **left pulmonary artery** to **arch of aorta** (distal to left subclavian).
  - After birth, it closes to form **ligamentum arteriosum**.
  - **Patent Ductus Arteriosus (PDA):** Persistence after birth ? left-to-right shunt, continuous machinery murmur.

- **Aortic Arch Aneurysm:**
    - Localized dilatation that can compress **left recurrent laryngeal nerve** ? **hoarseness**, **dyspnea**, **dysphagia** (Mediastinal Syndrome)

Pulmonary Trunk

- The **pulmonary trunk** is a **wide arterial vessel** that carries **deoxygenated blood** from the **right ventricle** to the lungs.
- **Origin:** From the **summit of the infundibulum (conus arteriosus)** of the right ventricle.
- **Length:** About **5 cm**; enclosed with the ascending aorta in a **common sleeve of serous pericardium**.
- **Position:** Lies **anterior** to the ascending aorta at its origin and overlies it.
- **Course:**
    - Runs **upward, backward, and to the left**.
    - Divides under the concavity of the aortic arch (at the **sternal angle**) into **right and left pulmonary arteries**.

Right Pulmonary Artery

- Passes **behind ascending aorta and superior vena cava**, **in front of esophagus**.
- Gives first branch to the **upper lobe of right lung** before entering the hilum.

Left Pulmonary Artery

- Passes **in front of descending thoracic aorta** to reach the **left lung hilum**.
- Connected to the **inferior surface of the aortic arch** by the **ligamentum arteriosum**, a remnant of **ductus arteriosus**.

Development of Arteries

- **Brachiocephalic Artery:** From **right aortic sac**.
- **Right Subclavian Artery:**
    - Proximal part ? **right 4th aortic arch**.
    - Distal part ? **right 7th cervical intersegmental artery**.
- **Left Subclavian Artery:** From **left 7th cervical intersegmental artery**.
- **Common Carotid Artery:** From **third aortic arch** and adjacent **dorsal aorta**.
- **External Carotid Artery:** As a **sprout** from the **third aortic arch**.
- **Pulmonary Trunk:** From **truncus arteriosus**.
- **Arch of Aorta:** From **left aortic sac + left 4th aortic arch + left dorsal aorta**.

Relation to Recurrent Laryngeal Nerve:

- **Left side:** Distal part of 6th aortic arch forms **ligamentum arteriosum** ? left recurrent laryngeal nerve hooks around it in thorax.
- **Right side:** Distal part disappears ? **right recurrent laryngeal nerve** hooks around **right subclavian artery** in neck

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Development of Superior Vena Cava (SVC)

- **Upper half (extrapericardial):** From **caudal part of right anterior cardinal vein**.
- **Lower half (intrapericardial):** From **right common cardinal vein**.
- **Coronary sinus:** From **left horn of sinus venosus**, receiving **great, middle, and small cardiac veins**

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Key Facts

- **Pulmonary trunk and ascending aorta** develop from the **truncus arteriosus** (common embryonic origin).
- They exhibit a **triple relationship**:
  1. Close to heart ? pulmonary trunk **anterior** to aorta.
  2. At heart's upper border ? pulmonary trunk **left** of aorta.
  3. Above ? right pulmonary artery **posterior** to ascending aorta