

# INTERNAL CONFIGURATION OF THE HEART

PR.M.D.EL AMRANI

**DR.CHAIMA KASSI** 

## PLAN:

- I. INTRODUCTION
- II. INTERVENTRICULAR SEPTUM
- III. INTERATRIAL SEPTUM
- IV. ORIFICES AT THE BASE OF THE HEART
- V. HEART CHAMBERS/CARDIAC CAVITIES
- VI. CONCLUSION

## I – INTRODUCTION:

- The heart's cavities are divided into right and left chambers.
- The right chambers, consisting of the right atrium and right ventricle, are separated from the left chambers, the left atrium and left ventricle, by the interatrial septum and interventricular septum, so that the heart appears to be formed by two independent halves, one on the right and the other on the left.

*Note :* The partitioning of the heart allows for the distinction of:

- A right heart, which receives the hypoxemic blood from the venae cavae and pumps it into the pulmonary artery.
- A left heart, which contains oxygenated blood, carried by the pulmonary veins and expelled into the aorta.



## **II – INTERVENTRICULAR SEPTUM:**



#### **<u>1. Shape – orientation:</u>**

- \_ The interventricular septum extends from the anterior wall to the inferior wall of the heart.
- It is triangular in shape, with its base facing the atria, where it continues with the \_ interatrial septum, and its apex pointing to the apex of the heart.
- Its right surface, belonging to the right ventricle, is convex, facing forward, to the right, and upward. Its left surface is concave, facing left and downward.
- It ends posteriorly along a very sinusoidal line, leaving:
  - On the right: the right atrioventricular orifice and that of the pulmonary artery;
  - On the left: the left atrioventricular orifice and the aortic orifice. •



11. Ventricular septum

9.

Longitudinal section of the left ventricle

#### 2. Structure :

The interventricular septum has two structural parts:

#### a. Muscular part :

- Thick, it comprises almost the entire septum and extends, becoming thinner, from the apex to the base.
- Its average thickness is around 1 cm.
- It gives rise on the right to the pillars of the septal leaflet of the tricuspid valve.

#### **b.** Membranous part (pars membranacea) :

- Thin, it is located at the base of the interventricular septum, in close proximity to the interatrial septum, opposite the posterolateral right part of the aortic orifice.
- Its left surface faces the ventricle.
- Its right surface provides the attachment for the septal leaflet of the tricuspid valve. In front of this leaflet, the septum is interventricular, while behind it, it is interatrialventricular, separating the anterior part of the right atrium from the left ventricle.

#### Note:

- Within the thickness of the interventricular septum runs the trunk of the His bundle.
- The interventricular septum can be the site of congenital malformations: these usually involve a partial absence. Complete absence is very rare.

#### **III – INTERATRIAL SEPTUM:**

- It is a thin membrane that separates the two atria from each other.
- It appears to continue anteriorly with the interventricular septum; along the rest of its border, it merges with the atrial walls opposite the interatrial sulcus.
- The interatrial septum, like the interventricular septum, is oriented in an oblique plane, with one of its surfaces facing right and the other left.



- 5. Right pulmonary vein
- 6. Opening of the right pulmonary vein
- 7. Left atrium
- 8. Left pulmonary vein
- 9. Opening of the left pulmonary vein
- 1. Interatrial septum
- 2. Left atrioventricular orifice
- 3. Fossa ovalis
- 4. Right atrium

- 10. Inferior vena cava
- 11. Opening of the coronary sinus
- 12. Coronary vessels
- 13. Right atrioventricular orifice

#### Frontal section of the atria showing the arrangement of the interatrial septum

#### Note: Malformations of the interatrial septum

- A persistent foramen ovale is the most common congenital malformation (present in 25% of individuals). These variants correspond to different stages in the development of the septum.
- A persistent interventricular foramen is also a common malformation.
- Complete absence of the septum, or of its muscular part, is rare.

#### **IV – ORIFICES AT THE BASE OF THE HEART:**



- 1. Nodule of a semilunar valve
- 2. Right semilunar valves
- 3. Right coronary artery
- 4. Fibrous rings of the aortic orifice
- 5. Anterior cusp
- 6. Septal leaflet
- 7. Posterior leaflet

- 8. Right atrioventricular fibrous ring
- 9. Artery of the atrioventricular node
- 10. Fibrous ring of the pulmonary artery orifice
- 11. Anterior semilunar valve
- 12. Left semilunar valves
- 13. Left fibrous trigone
- 14. Posterior semilunar valves

#### Heart valves (superior view)

- 15. Circumflex branch of the left coronary artery
- 16. Anterior cusp
- 17. Posterior cusp
- 18. Left atrioventricular fibrous ring
- 19. Coronary sinus
- 20. Left fibrous trigone

- The ventricles are two pyramidal or conical cavities, located in front of the atria, on either side of the interventricular septum.
- The apex of the ventricles corresponds to the apex of the heart.
- The base of each ventricle, oriented posteriorly, is entirely occupied by two circular orifices:
  - One atrioventricular orifice, which connects the atrium to the ventricle;
  - The other, a smaller arterial orifice, connects the right ventricle to the pulmonary artery, and the left ventricle to the aorta.



- 1. Aorta
- 2. Pulmonary vein
- 3. Left pulmonary artery
- 4. Left atrium
- 5. Aortic valve
- 6. Mitral valve
- 7. Left ventricle

- 8. Superior vena cava
- 9. Right atrium
- 10. Inferior vena cava
- 11. Pulmonary valve
- 12. Tricuspid valve
- 13. Right ventricle

#### Schematic frontal section showing the arrangement of arterial and ventricular orifices

Note: Ostial stenoses are common.

#### **<u>1.</u>** Atrioventricular orifices:



Diagram of an atrioventricular valve apparatus

- Each of them is equipped with a valvular apparatus called an atrioventricular valve.
- These valves have the shape of a membranous funnel, attached by its base to the border of the atrioventricular orifice, and projecting into the ventricular cavity.
- They are divided into several leaflets by deep indentations. Each leaflet presents:
  - A smooth axial surface facing the atrium.
  - A parietal (peripheral) surface oriented toward the ventricle, made uneven by the attachment of tendinous cords.
  - An adherent border joined to the border of the atrioventricular orifice, implanted on the fibrous ring.
  - And a notched free border.



- 1. Fibrous ring
- 2. Cusp
- 3. Albini's nodules
- 4. Third-order chordae tendineae
- 5. Second-order chordae tendineae
- 6. First-order chordae tendineae
- 7. Papillary muscle

Diagram of an atrioventricular valve showing the insertion of the chordae tendineae.

#### a. Right atrioventricular orifice:

- It is a valvular apparatus located at the inferior part of the base of the right ventricle. It connects the right ventricle with the right atrium.
- Its circumference is 120 mm in men and 105 mm in women.
- The tricuspid valve is divided by three notches into three cusps or triangular leaflets:
   anterior, inferior, and medial. Attached to these leaflets are the papillary muscles of the right ventricle:
  - The septal leaflet receives chordae tendineae from the conal papillary muscle and the inferior papillary muscle.
  - The anterior leaflet receives chordae from the anterior papillary muscle and the conal papillary muscle.
  - The inferior leaflet receives chordae from both the inferior and anterior papillary muscles.

#### b. Left atrioventricular orifice:

- This orifice occupies the inferior part of the base of the heart.
- It is located to the left of the tricuspid orifice.

- Around its border, which measures 110 mm in men and 90 mm in women, is attached the mitral valve, which has two cusps or leaflets: a right (large) leaflet and a left (small) leaflet, to which are connected the papillary muscles of the left ventricle:
  - The tendinous cords from the anterior papillary muscle attach to the upper halves of both leaflets.
  - The tendinous cords from the posterior papillary muscle attach to the lower halves of both leaflets.

**Note** : The chordae tendineae prevent the valves from prolapsing during ventricular contraction. The rupture of the chordae leads to mitral or tricuspid insufficiency.

#### 2. Arterial orifices:



- 1. Fibrous ring
- 2. Morgagni's nodule (pulmonary artery) / Arantius' nodule (aorta)
- 3. Semilunar or sigmoid valve

#### Superior view of an arterial orifice at the level of the heart

- Each of them is equipped with three leaflets, the semilunar valves.
- These values are thin membranous folds that form pocket-like cavities with the arterial wall to which they are attached.
- Each leaflet can be recognized by:

- A superior or parietal surface, which is concave.
- An inferior or axial surface, which is convex.
- An adherent concave border by which the valve attaches to the wall.
- A free horizontal edge. In the middle of this edge, there is a small bulge formed by a fibrous nodule, called the nodule of Arantius for the aortic valves, and the nodule of Morgagni for those of the pulmonary orifice.

Note : There are no tendinous cords for the semilunar leaflets.



Anterior view of an open arterial orifice

#### a. Pulmonary orifice :

- This orifice occupies the anterosuperior part of the base of the heart, and follows the pulmonary infundibulum.
- It is located above, in front of, and to the left of the tricuspid orifice.

- It is circular and measures approximately 25 mm in diameter.
- It has three leaflets:
  - anterior;
  - right posterior;
  - and left posterior.

*Note* : The most common malformative associations are:

- **Tetralogy of Fallot**, which includes: pulmonary stenosis, a ventricular septal defect, right ventricular hypertrophy, and an aorta overriding the ventricular septal defect.
- **Tricuspid atresia**, which includes: pulmonary ostium stenosis, an atrial septal defect, and right ventricular hypertrophy.



#### Schematic longitudinal section of the infundibulum

#### **b.** Aortic orifice :

- This orifice occupies the upper part of the base of the heart.
- It is more anterior than the mitral orifice and located behind the pulmonary orifice.
- Around its border, which measures on average 25 mm, are attached the three sigmoid valves, oriented opposite to their counterparts in the pulmonary artery, and distinguished as:
  - posterior;
  - left anterior;

#### • and right anterior.



Longitudinal section of the sinus of Valsalva

#### c. The projection of the orifices of the base of the heart on the anterior thoracic wall :

The sounds produced by the different valves during their closure are best heard at the point where the blood flow from these valves comes closest to the thoracic wall, as follows:

- The aortic valve is best heard at the level of the second right chondrosternal joint.
- The pulmonary valve is best heard at the level of the left sternal border of the second intercostal space.
- The tricuspid valve is best heard at the level of the fifth right chondrosternal joint.
- The mitral valve is best heard in the fifth left intercostal space inside the midclavicular line.



- 1. Projection of the pulmonary valve
- 2. Auscultation site of the pulmonary valve
- 3. Projection of the mitral valve
- 4. Auscultation site of the mitral valve

- 5. Auscultation site of the aortic valve
- 6. Projection of the tricuspid valve
- 7. Auscultation site of the tricuspid valve
- 8. Projection of the aortic valve

#### Anterior view of the thorax showing the projection of the heart valves on the thoracic wall

#### Note :

- During cardiac auscultation, two heart sounds are usually audible:
  - The first sound (S1), at the beginning of systole, is caused by the closure of the atrioventricular valves, the tricuspid and mitral valves. Its tone is dull and maximal at the apex of the heart (onomatopoeia: "toum").
  - The second sound (S2), at the beginning of diastole, is caused by the closure of the semilunar valves, the aortic and pulmonary valves. Its tone is higher and drier, maximal at the base of the heart (onomatopoeia: "ta").
- Cardiac activity can be detected by ultrasonography starting from the 8th week of amenorrhea.

### V – HEART CHAMBERS / CARDIAC CAVITIES:

#### 1. The atria:

The atria have thinner walls than the ventricles, and their shape is cubic.

#### a. Right atrium:



#### Right lateral view after opening the wall showing the interior of the right atrium

- It is ovoid with a vertical major axis.
- In front of its lateral wall, the orifice of the right atrium is visible. This is a cavity whose walls are raised by numerous fleshy columns of the second and third orders.
- The medial or septal wall is formed by the interatrial septum. It presents a rounded depression, the fossa ovalis, limited by a prominent ring, interrupted at the bottom and posteriorly, known as the Vieussens' ring (or limbus of Vieussens).
- The superior wall presents the non-valvular orifice of the superior vena cava. It is circular,
   with a diameter of approximately 2 cm.

- The inferior wall is excavated with two orifices:
  - Posteriorly, the orifice of the inferior vena cava, 3 cm in diameter, located at the junction of the inferior and posterior walls, with an anterior-inferior edge that presents a lamellar protrusion, the Eustachian valve.
  - Anteriorly and medially, the orifice of the coronary sinus, which has a diameter of 12 mm, and is limited anteriorly and inferiorly by a thin fold called the Thebesian valve.
- The posterior wall is smooth, presenting a transverse protrusion between the orifices of the two caval veins, known as the Lower tubercle.

*Note :* In the fetus, it directs the blood from the superior vena cava toward the right atrioventricular orifice.

- The right edges of the caval openings are united by the terminal crest, which corresponds to the terminal sulcus at the base of the heart.
- The anterior wall corresponds to the right atrioventricular orifice or tricuspid valve.
   Above it and laterally, the right auricle opens, and its cavity is partitioned by fleshy trabeculae.

#### b. Left atrium :



#### Left lateral view after opening the wall showing the interior of the left atrium

- It is ovoidal with a long transverse axis.
- The lateral wall is smooth and presents, in front, at the junction with the anterior wall, the orifice of the left auricle.
- The medial wall is formed by the interatrial septum. Often, a projection can be seen here, corresponding to the fossa ovalis of the right atrium, and it is limited in front by a membranous crescent, the semilunar fold.
- The superior and inferior walls are smooth and narrow.
- The anterior wall corresponds to the left atrioventricular orifice.
- The posterior wall is perforated by the four rounded ostia of the pulmonary veins.

#### 2. The ventricles:

#### a. Right ventricle:



- 1. Infundibulum
- 2. Wolf's spur
- 3. Pillar of the conus arteriosus
- 4. Moderator band and papillary muscle
- 5. Septal papillary muscle
- 6. Anterior papillary muscle

- 7. Posterior papillary muscle
- 8. Pulmonary valve
- 9. Septal leaflet
- 10. Anterior leaflet
- 11. Posterior leaflet

#### Right lateral view of the heart after opening the right ventricle

- It has the shape of a triangular pyramid with three walls, a base, and an apex.
- The anterior wall corresponds to the sternocostal surface of the heart. It features, in its middle part, the anterior papillary muscle.
- The posterior wall corresponds to the diaphragmatic surface of the heart. It gives
  insertion to the posterior papillary muscle and the moderator band, whose free edge is
  concave and posterior.
- The septal wall, formed by the interventricular septum, presents, in its postero-superior part, the supraventricular crest.
- This crest includes a smooth upper area, the conus arteriosus, and a lower area, where the septal papillary muscles and the moderator band attach. The moderator band

stretches from the anterior wall to the medial wall, forming a curve with its concavity facing the base of the ventricle.

*Note :* The moderator band, which links the ventricular walls together, resists the dilating pressure stresses of the right ventricle.

- The base contains the right atrioventricular orifice and the orifice of the pulmonary artery.
- The apex is partitioned by muscular trabeculae.
- The right ventricular cavity extends upwards and to the left in the form of a funnel, whose truncated segment corresponds to the pulmonary orifice.
   this extension, called the infundibulum, shows on its medial wall the boundary that separates it from the rest of the ventricular cavity an oval-shaped ridge known as the spur of Wolf.
- The right ventricular cavity has two blood flow chambers, right and left, separated by the moderator band and the septal cusp:
  - the right (inflow) chamber lies opposite the right atrioventricular orifice.
  - the left (outflow) chamber lies opposite the pulmonary artery orifice and the conus arteriosus.

#### **b.** Left ventricle:



#### Left lateral view after opening the wall showing the interior of the left ventricle

- Its walls are much thicker than those of the right ventricle.
- It has the shape of a cone flattened transversely, so that one can distinguish: two walls,
   two borders, a base, and an apex.
- The right wall is formed by the interventricular septum.
- The left wall is irregular, with numerous muscular trabeculae.
- The base includes the left atrioventricular orifice and the aortic orifice.
- The anterior border and the adjoining part of the left wall provide insertion for the anterior papillary muscle in their anterior third.
- The posterior border and the adjacent portion of the right wall give insertion to the posterior papillary muscles in their anterior part.
- The ventricular cavity is crossed by tendinous cords, stretched from the apices of the papillary muscles to the anterior and posterior cusps, dividing it into two chambers:

- a left chamber (also called the venous or inflow chamber) opposite the left • atrioventricular orifice.
- a right chamber (also known as the arterial or outflow chamber) opposite the aortic orifice.

#### c. Walls of the ventricles:



5. Pericardium

#### Longitudinal section through the ventricular cardiac muscle

They are lined with muscular projections called trabeculae carneae, which are classified into three types:

First-order trabeculae, also known as papillary muscles, are conical in shape and • attached by their base to the ventricular wall.

from their apex arise small tendinous cords that insert into the borders and parietal surface of the atrioventricular valve. Based on their insertion points, the chordae tendineae are divided into three categories:

- o first-order chordae attach to the adherent margin of the valve,
- o second-order chordae insert on the parietal surface,
- third-order chordae fix onto the free edge.
- Second-order trabeculae are anchored to the ventricular wall at both ends, and free along the rest of their length.
- Third-order trabeculae are fully attached to the wall along their entire length.



- 1. Cusps
- 2. Trabeculae carneae
- 3. First-order chordae tendineae

- 4. Second-order chordae tendineae
- 5. Third-order chordae tendineae
- 6. Papillary muscles

#### Tendinous and muscular structures of the heart (schematic)

#### VI – CONCLUSION:

- In summary, the heart's internal configuration reflects its complex yet highly organised structure, ensuring efficient unidirectional blood flow.
- Each chamber has distinctive features—from the smooth-walled atria to the muscular ventricles lined with trabeculae carneae.
- The valves and their supporting structures, including chordae tendineae and papillary muscles, work in harmony to maintain proper valve function and prevent

regurgitation. together, these anatomical elements illustrate the precision of cardiac architecture in supporting its vital function.