



Anatomy of the Aortic Valve

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The earliest documented interest in the anatomy of the aortic valvar complex stems from the Renaissance, with the description and drawings by Leonardo da Vinci (1513). Today, the need for accurate knowledge of the aortic valvar complex is imperative, especially for percutaneous therapies of the aortic valve.

The substantial changes in size and shape of the valve cusps and leaflets that occur during the cardiac cycle are facilitated by a highly complex internal microarchitecture. The layered structure of the aortic valve is formed by a dense collagenous layer close to the outflow surface, which provides the primary strength component, a central core of loose connective tissue, and an elastin layer below the inflow surface [1].

The aortic valve should be considered within the wider context of its anatomical and functional unit, namely, the aortic root. The latter is the connection between the left ventricle and the ascending aorta, and is located on the right, posteriorly to the subpulmonary infundibulum; its posterior margin is wedged between the mitral valve orifice and the muscular portion of the interventricular septum. The aortic root goes from the basal plane where the aortic valve leaflets enter the left ventricle to the peripheral point where they enter the sinotubular junction (Fig. 13.1) [2]. About two-thirds of the circumference of the lower part of the aortic root are connected to the muscular portion of the interventricular septum.

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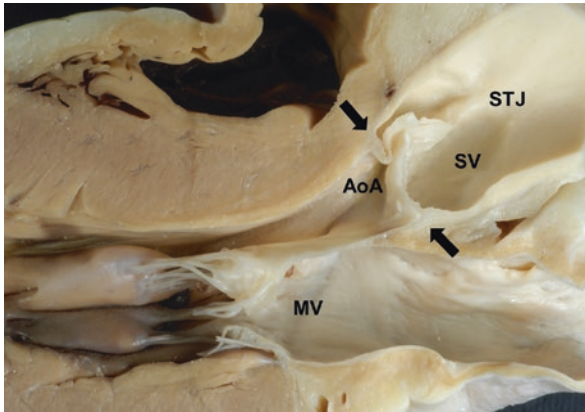


Fig. 13.1 Long axis showing the aortic root between the aortic annulus (AoA) and the sinotubular junction (STJ). SV sinus of Valsalva, black arrows margins of aortic annulus, MV mitral valve

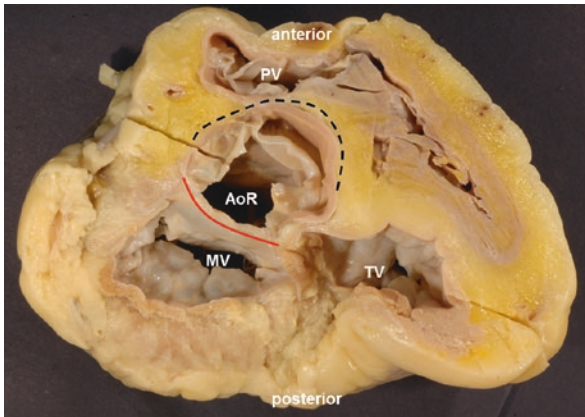


Fig. 13.2 Short-axis view of the cardiac basis: about two-thirds of the circumference of the lower part of the aortic root are connected to the muscular portion of the interventricular septum (black dotted line). The remaining one-third is in continuity with the anterior aortic leaflet (red line). AoR aortic root, MV mitral valve, PV pulmonary valve, TV tricuspid valve

The remaining one-third is in continuity with the aortic leaflet of the mitral valve (Fig. 13.2). Its components include the annulus, valve leaflets, commissures, sinuses of Valsalva, sinotubular junction, and interleaflet triangles.

13.1 The Annulus

The aortic root contains at least three circular rings and one crown-like ring [3]. The valvular leaflets are attached throughout the length of the root. The three-dimensional arrangement of the leaflets takes the form of a three-pointed crown, with the hinges from the supporting ventricular structures forming the crown-like ring. The base of

the crown is a virtual ring, commonly known as the “annulus,” formed by the plane joining the basal points where the leaflets enter the left ventricle. The crown’s upper part is a true ring, called the sinotubular junction, forming the point where the aortic root opens into the ascending aorta. The semilunar lines of attachment cross another true ring, the anatomic ventriculo-aortic junction. Though there have been generic descriptions of the annulus, in the aortic valve it can be said that the annulus takes on the cylindrical shape of the aortic root, in which the valve leaflets are supported by a crown-shaped structure [2].

The diameter of the aortic annulus in a normal adult usually ranges between 21 and 24 mm [4].

13.2 The Leaflets

The aortic valve is normally tricuspid. The valve’s proper functioning depends on the correct relationship between the leaflets inside the aortic root. The leaflets consist of a core of fibrous tissue inside an endothelial sheath on both the arterial and ventricular side. The locus where they originate from the supporting ventricular structures gives way to the fibroelastic walls of the aortic valvar sinuses and marks off the anatomic ventriculo-aortic junction.

Each leaflet is composed of an attachment, body, coaptation surface, and lunule with the nodules of Arantii. The nodules of Arantii are located halfway on the free margin of the coaptation surface. On both sides of this nodule, there is a thin portion called a “lunule”; it consists of a margin, which is thin at its free end and continues into the coaptation area where the three leaflets meet and allow for complete valve closing. The lunules are attached to the wall of the aortic root in the area of the commissures. The main part of each leaflet is called “body.” As specified above, the attachment is the area where the leaflet joins the aortic root [5]. Considering the size of the leaflets, it can be said that the non-coronary leaflet tends to be larger, followed by the left coronary leaflet, and the right coronary leaflet, though these differences are not significant (Fig. 13.3) [4, 6, 7].

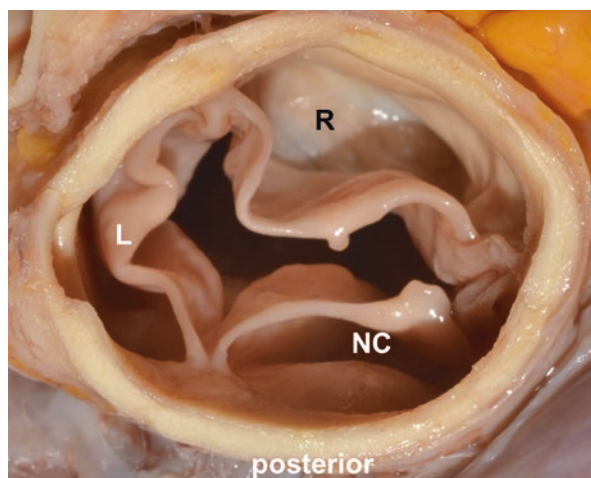


Fig. 13.3 Aortic view showing the left (L), right (R), and non-coronary (NC) cusps

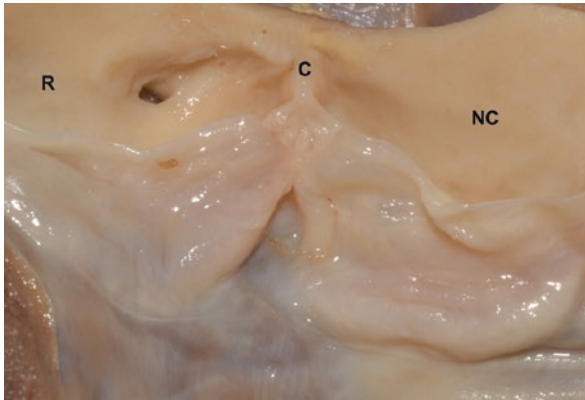


Fig. 13.4 The commissure between the right (*R*) and non-coronary (*NC*) leaflets

13.3 The Commissures

The top of the crown-shaped structure in the area where the lunules of two leaflets are attached to the aortic wall at the sinotubular junctions is called the commissure (Fig. 13.4).

There are three commissures. The commissure between the right and left leaflets is located anteriorly, more or less in front of the matching commissure of the pulmonary valve. The one between the right and non-coronary leaflets is located anteriorly to the right, and the one between the left and non-coronary leaflets is usually located on the posterior face of the aortic root. The commissures have a fibrous structure and support the valvular leaflets located above the three triangular areas called interleaflet triangles.

13.4 The Interleaflet Triangles

As a result of the semilunar attachment of the aortic valvular leaflets, there are three triangular extensions of the left ventricular outflow tract that reach to the level of the sinotubular junction [8]. These triangles are formed not of ventricular myocardium but of the thinned fibrous walls of the aorta between the expanded sinuses of Valsalva.

The triangle between the right and left sinuses is located in front of the pulmonary valve. The triangle between the right and non-coronary sinuses is located in front of the right atrium and is proximally in continuity with the membranous septum. This is the area where the conduction system is closely linked to the aortic root. This has major implications, allowing for the introduction of alterations in conduction following percutaneous aortic valve replacement. The bundle of His is an anterior extension of the atrioventricular node. It penetrates through the central fibrous portion just below the lower margin of the membranous ventricular septum at the ridge of the muscular ventricular septum right below this triangle, which is closely interconnected with the septal leaflet of the tricuspid valve.

Finally, the triangle between the left and non-coronary sinuses is inferiorly in direct continuity with the aortic or anterior leaflet of the mitral valve. These triangles separate and mark off the three sinuses in a normal valve (Fig. 13.5) [3, 9].

13.5 The Sinuses of Valsalva

The sinuses of Valsalva are defined as expanses separating the ventricle and aorta (Figs. 13.1 and 13.6).

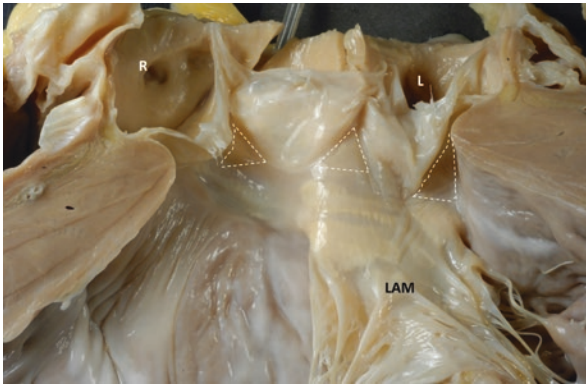


Fig. 13.5 Interleaf triangles. *L* left coronary ostium, *LAM* anterior mitral leaflet, *R* right coronary ostium

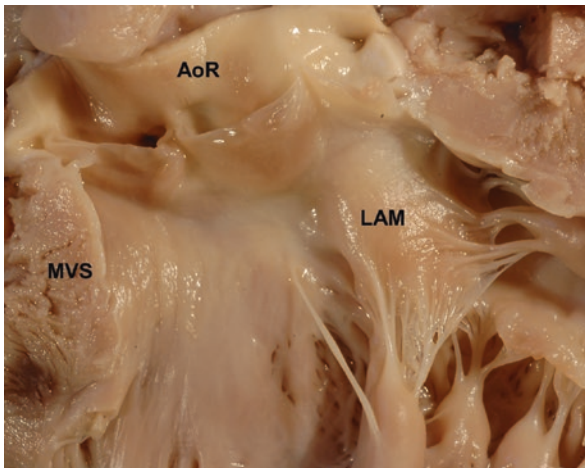


Fig. 13.6 Gross view of the left ventricular outlet: the posterior sinus of Valsalva wedged between the orifice of the anterior mitral leaflet (LAM) and the muscular ventricular septum (MVS). *AoR* aortic root

They border superiorly or distally with the sinotubular junction, and inferiorly or proximally with the valvar leaflet attachments. Each sinus takes its name from the coronary cusp it originates from (right, left, or non-coronary) [10] (Fig. 13.3).

The coronary orifices normally originate from the two anterior right and left sinuses of Valsalva, usually right below the sinotubular junction. Their origin may vary from patient to patient. The distance from the annular plane can vary greatly, and there are some congenital anatomic variants, which are very often associated with the bicuspid aortic valve [11]. Knowledge of the precise position of the coronary, ostia, and accurate measurement of the distance from the annulus is of the utmost importance during the screening of patients undergoing percutaneous aortic valve replacement. If this distance is too small, there is a risk of coronary occlusion by the aortic leaflets displaced by the device.

13.6 The Sinotubular Junction

The sinotubular junction marks the transition from the aortic root to the ascending aorta, and also the upper part of the attachment of each valve leaflet (Fig. 13.1). The mean diameter of the sinotubular junction ranges between 22 and 26 mm [4]. Dilatation of the aortic root at this point has been associated with the onset of aortic failure.

References

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