

Anatomy of the heart

Robert H Whitaker

Abstract

Despite centuries of writings and research into cardiac anatomy and function, the topic is still advancing, particularly in relation to clinical applications and embryological significance. This article presents the heart with reference to the classical anatomical position and attempts to clarify the nomenclature that is most commonly used by anatomists. We encourage clinicians to use the same terminology. The references are from an excellent compilation on the heart in *Clinical Anatomy*.

Keywords Atrium; cardiac embryology; chambers; coronary arteries; heart; pericardium; venous drainage; ventricle

The heart is a midline, valvular, muscular pump that is cone-shaped and the size of a fist. In adults, it weighs 300 grams and lies in the middle mediastinum of the thorax. The inferior (diaphragmatic) surface sits on the central tendon of the diaphragm, whereas the base faces posteriorly and lies immediately anterior to the oesophagus and (posterior to that) the descending aorta. The base comprises mainly the left atrium. The left surface (left ventricle) and right surface (right atrium) are each related laterally to a lung and a phrenic nerve in the fibrous pericardium. The anterior surface of the heart lies behind the sternum and the costal cartilages. The constituent parts of the anterior and inferior surfaces are dictated largely by the position of the interventricular septum. Although essentially a midline structure, one-third of the heart lies to the right of the midline and two-thirds to the left.

The interventricular septum bulges to the right because the wall of the left ventricle is much thicker (10 mm) than that of the right ventricle (3–5 mm). It also lies obliquely across the heart, almost in the coronal plane, such that the anterior surface of the heart is two-thirds right ventricle and one-third left ventricle; the proportions are reversed on the inferior surface. The thicker, muscular part of the interventricular septum is formed from the ventricular walls. The muscles of the four chambers and the four valves are attached to, and supported by, a figure-of-eight-shaped fibrous skeleton comprising a central fibrous body and extensions (fila coronaria) that surround the valves. This skeleton both divides and separates the atria electrically from the ventricles and is the remnant of the atrioventricular (AV) cushions. The thinner membranous part of the interventricular septum is formed from the lowest aspect of the spiral valve (neural crest cells), which divides the truncus arteriosus into the aorta and pulmonary trunk.

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What's new?

- The anatomy of the coronary sinus has taken on new clinical importance as a result of the expansion of electrophysiological investigations and interventions. There has been a drive to avoid the 'Valentine' approach to cardiac description that has crept into surgical usage and an appreciation of the need to adhere to strict anatomical references¹
- The embryology of the heart has been revisited in an attempt to gain more insight into congenital anomalies² — the classical concepts of cardiac looping and fate of the original heart tubes have been questioned³
- New and much improved methods of imaging the heart are now available

Pericardium

The pericardium holds and protects the heart, but provides sufficient potential space for filling and emptying of the chambers. The outer layer is the tough fibrous pericardium, which blends with the adventitia of the aorta, the pulmonary trunk, the superior vena cava and the central tendon of the diaphragm. Within this, there are two layers of serous pericardium.

- a visceral layer surrounding the heart
- a parietal layer lining the inner surface of the fibrous pericardium

These two layers of serous pericardium are continuous with each other as they reflect off the major vessels behind and above the heart. The reflection, posteriorly, between the pulmonary veins is termed the 'oblique sinus' of the pericardium. The plane between the superior vena cava and the pulmonary veins posteriorly, and the aorta and pulmonary trunk anteriorly, made by the folding of the heart, is termed the 'transverse sinus' of the pericardium.

The visceral layer and the heart itself are supplied by sympathetic nerves from the cardiac plexuses; these in turn carry general visceral afferent fibres to the vertebral levels from which the sympathetic supply arises, which are the three cervical sympathetic ganglia and the T1–5 ganglia — this explains why cardiac pain is referred to the neck, chest and arm.

Features of the chambers

Right atrium

The inferior vena cava passes through the diaphragm at the level of T8 and immediately enters the right atrium, which lacks a true valve. In the fetus, however, there is the so-called valve of the inferior vena cava, a fold of tissue that directs caval blood into the foramen ovale. The superior vena cava enters the superior aspect of the chamber. The fossa ovalis (a remnant of the septum primum) and its overhanging limbus (a remnant of the septum secundum) lie on the smooth, interatrial part of the chamber, which developed from the sinus venosus. This smooth area is separated from the muscular part, with its muscoli pectinati, by the crista terminalis internally and the sulcus terminalis externally. The muscular part originated from the fetal atrium and is represented in the mature heart as the right auricle.

Between the opening of the inferior vena cava and the AV orifice lies the opening of the coronary sinus, which is protected