Anatomy and Physiology of the Pericardium

Brian D. Hoit, MD

KEYWORDS

• Pericardium • Ventricular interaction • Mesothelium • Hemodynamics

KEY POINTS

- The pericardium is composed of visceral (epicardial) and parietal (fibrous pericardial) components: the former reflects over the great vessels, creating sinuses and recesses (a major component of the pericardial reserve volume), and becomes the serosal layer of the latter, which has ligamentous attachments to the sternum, spine, and diaphragm.
- Histologically, the relatively inelastic fibrous pericardium is composed of functionally arranged compact collagen layers interspersed with short elastin fibers; the visceral pericardium is a mesothelial monolayer with numerous microvilli, which provide friction-bearing surfaces and increase surface area.
- The pericardium is not essential for life, but serves important mechanical functions (eg, constraint of ventricular filling, ventricular interaction) that are subtle in healthy individuals, but are critical in disease states characterized by a rapid increase in heart size.
- Other functions of the pericardium include membranous (equalizing gravitational, hydrostatic, and inertial forces and reducing friction over the surface of the heart, and serving as a barrier to infection); metabolic; ligamentous (limiting excessive displacement of the heart); and reflexive (hemodynamic neuromodulation).
- The mesothelium of the pericardium is metabolically active and produces prostacyclins and other substances that modulate epicardial coronary arterial tone, fibrinolysis, and sympathetic neurotransmission.

ANATOMY OF THE PERICARDIUM

The pericardium is composed of visceral and parietal components. The visceral pericardium is a mesothelial cell monolayer that adheres firmly to the epicardium, reflects over the origin of the great vessels, and becomes the serosal layer of the parietal pericardium, a tough, fibrous tissue that envelops the heart. The pericardial space is enclosed between these 2 layers and normally contains up to 50 mL of pericardial fluid. Pericardial fluid is largely a plasma ultrafiltrate, but may include myocardial interstitial fluid and lymph drainage.[1] Pericardial fluid volume is greatest over the atrioventricular and interventricular grooves; over the flatter surfaces of the heart, there is only a thin film of fluid. Thus, only a potential space is present over most of the cardiac surface, a fact that has implications for how pericardial pressure is measured and for how the restraining effect of the pericardium on cardiac volumes is estimated. The thickness of the pericardium varies by region (~0.8–1.0 mm thick on anatomic specimens) and is slightly greater on imaging studies (0.7–1.2 mm by cardiac computed tomography [CT] and 1.5 to 2.0 mm by cardiac magnetic resonance [CMR]).[2,3]

There are no disclosures to report.
Department of Medicine (Cardiology), Case Western Reserve University, Harrington Heart and Vascular Center, University Hospitals Cleveland Medical Center, 11100 Euclid Avenue, Cleveland, OH 44106-5038, USA
E-mail address: bdh6@cwru.edu

Cardiol Clin 35 (2017) 481–490
http://dx.doi.org/10.1016/j.ccl.2017.07.002

Pericardial Sinuses and Recesses

Pericardial reflections around the great vessels and pulmonary veins result in the formation of the oblique sinus, a U-shaped midline cul-de-sac behind the left atrium between the pulmonary veins and inferior vena cava; the transverse sinus, a tunnellike passageway between the anterior and posterior pericardial cavity, which is bounded anteriorly by the aorta and main pulmonary artery, and posterolaterally by the atria and their appendages, and the superior venal cava; and extensions of the transverse sinus, the pericardial recesses (Fig. 1, Table 1). Recesses can be seen on advanced imaging studies (CT, CMR, and transesophageal echocardiography) and surgical or postmortem examination. These potential spaces (particularly the oblique sinus) are major contributors to the pericardial reserve volume (ie, the difference between unstressed pericardial volume and cardiac volume) that accommodates physiologic changes in ventricular filling. The phrenic nerves and pericardiophrenic vessels are contained in a bundle between the fibrous pericardium and the mediastinal pleura that courses anterior to the pulmonary hilum.

Attachments of the Pericardium

The fibrous pericardium is attached to the adventitia of the great arteries, cervical fascia, and the central tendon of the diaphragm; it is more loosely attached to the esophagus and the descending aorta posteriorly and to the left leaf of the diaphragm inferiorly. Several pericardial ligaments firmly affix the pericardium in the thorax: anterosuperiorly to the manubrium by the superior pericardiosternal ligament, antero-inferiorly to the xiphoid process by the inferior pericardiosternal ligament, posteriorly to the vertebral column, and inferiorly to the central tendon of the diaphragm (Fig. 2). The fibrous pericardium contacts the chest wall behind the fifth to seventh costal cartilages, an area known because of pericardiocentesis as the "triangle of safety."

The Epicardium

Between the visceral pericardium (epicardium) and the subjacent myocardium is an inconstant amount of epicardial fat (most prominent in the atrioventricular and interventricular grooves and right ventricular [RV] free wall) that contains

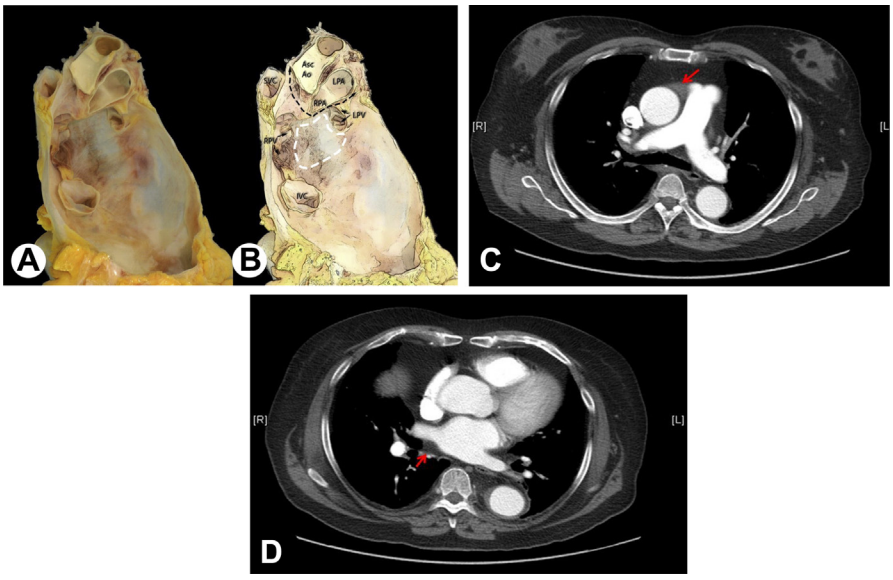

Fig. 1. (*A*) Lateral dorsal and diaphragmatic aspects of the pericardial sac after removal of the anterior portion of the pericardial sac and heart. The aorta and pulmonary trunks are enclosed in one sheath and the pulmonary veins and venae cavae are covered in another. (*B*) The transverse sinus (*dashed black arrow*) forms a tunnel between the arterial and venous pericardial reflections, creating access between the right and left sides of the pericardial cavity. The inverted U-shaped cul-de-sac behind the left atrium between the pulmonary veins is the oblique sinus (*dashed white line*). (*C*) Contrast-enhanced CT axial image demonstrating the superior aortic recess of the transverse sinus (*arrow*). (*D*) Contrast-enhanced CT axial image demonstrating the oblique sinus (*arrow*). Asc Ao, ascending aorta; IVC, inferior vena cava; LPA, left pulmonary artery; LPV, left pulmonary vein; RPA, right pulmonary artery; RPV, right pulmonary vein; SVC, superior vena cava. (*Reproduced from* Klein AL, Abbara S, Agler DA, et al. American Society of Echocardiography clinical recommendations for multimodality cardiovascular imaging of patients with pericardial disease. J Am Soc Echocardiogr 2013;26:965–1012; with permission.)