Chapter 1
The Physiological Basis of Coronary Circulation

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The high prevalence of cardiovascular diseases in developed countries, particularly coronary heart disease, has resulted in an increasing interest in the physiological basis of the circulatory system and coronary flow [1-4]. The study of the physiology helps us understand cardiovascular pathologic disorders and their clinical manifestations better. But it also allows us to learn about some aspects of the diagnostic tools applied in cardiovascular disease, since most of them aim to disclose abnormalities in coronary flow. These techniques use some type of tracer, a substance that travels through the coronary circulation and interacts with the cells of the vascular wall and the myocytes, reflecting the state, normal or abnormal, of the blood flow. This is the case of isotopic diagnostic techniques (SPECT, PET), the most recent technologies of cardiac magnetic resonance imaging or myocardial contrast-enhanced echocardiography – the topic of this book [5-7].

This chapter reviews the principal features involved in the regulation of coronary circulation. The anatomy of the coronary circulation, the regional nature of myocardial perfusion, the general basis of the regional regulation of the blood flow are important topics discussed. In addition, the specific landmarks involved in the control of regional myocardial blood flow, such as the metabolic demand, the role of the extravascular compressive forces, the characteristics of transmural myocardial perfusion, coronary autoregulation or the complex relationship between flow and contractile function, are described below.

Coronary Anatomy and the Regional Nature of Myocardial Perfusion

The coronary circulatory system includes the great epicardial vessels, the small vessels that are not imaged with angiography, the capillaries and the veins [8]. The epicardial vessels comprise the left and the right
coronary arteries and their principal branches. Coronary arteries normally emerge from the ostia located at the corresponding left and right aortic sinus of Val- salva. In 50% of the population, there is a third ostia where the conus artery arises. In the rest, this vessel is the first branch of the right coronary artery (RCA).

The left coronary artery (LCA) runs a variable distance of some millimeters before subdividing into the left anterior descending (LAD) and left circumflex (LC) arteries. The size of the principal branches of the LCA decreases as they travel over the cardiac surface. The size of the RCA, loss of major bifurcation, remains constant until it arrives at the posterior area of the heart, the so-called crux, where the right posterior descendent artery (RPD) arises. The LCA and RCA run embedded in the epicardial fat and are located at the A-V sulcus.

The LAD arteries pass along the interventricular sulcus. From its origin, the most important branches are the anterior septal and diagonal arteries. The Anterior septal arteries, also called anterior perforator arteries, penetrate into the interventricular septum. Diagonal arteries runs over the antero-lateral surface of the left ventricle.

The Circumflex artery goes into the A-V sulcus and along its way bifurcates into several marginal arteries, variable in number and of important size. These branches of the LC arteries perfuse the lateral and posterior region of the left ventricle. In 50% of the population, the LC is the origin of the sinus node artery and in 10%-15% the RPD arises from it, a condition called left dominance.

Fig. 1.1. Regional distribution of coronary flow. Echocardiographic views in parasternal long axis (A), paraster nal short axis (B), apical four-chambers (C) and apical two-chambers (D). The areas of myocardium have been highlighted with the color corresponding to the major epicardial coronary artery responsible for their perfusion. LAD, left anterior descending coronary artery; CA, circumflex coronary artery; RCA, right coronary artery.