CHAPTER 1

Introduction

The electrocardiogram (ECG), introduced into clinical practice more than 100 years ago by Einthoven, constitutes a lineal recording of the heart's electrical activity that occurs successively over time. An atrial depolarisation wave (P wave), a ventricular depolarisation wave (QRS complex) and a ventricular repolarisation wave (T wave) are successively recorded for each cardiac cycle (Figures 1A–C). As these different waves are recorded from different sites (leads) the morphology varies (Figure 2). Nevertheless, the sequence is always P–QRS–T. An ECG curve recorded from an electrode facing the left ventricle is shown in Figure 1D. Depending on the heart rate, the interval between waves of one cycle and another is variable.

Other different forms of recording cardiac activity (vectorcardiography, body mapping, etc.) exist [1]. Vectorcardiography (VCG) represents electrical activity by different loops originating from the union of the heads of multiple vectors of atrial depolarisation (P loop), ventricular depolarisation (QRS loop), and ventricular repolarisation (T loop). A close correlation exists between VCG loops and the ECG curve. Therefore, one may deduct ECG morphology on the basis of the morphology of VCG loop and vice versa. This is due to loop–hemifield correlation theory (see p. 10). According to this correlation (Figures 16, 18 and 21), the morphology of different waves (P, QRS and T) recorded from different sides (leads) varies (Figure 2). As the heart is a three-dimensional organ, projection of the loops with their maximum vectors in two planes, frontal and horizontal, on the positive and the negative hemifield* of each lead is required to ascertain exactly the loop's location and allow deducting ECG morphology (Figures 3 and 4). The morphology of ECG depends not only on the maximum vector of a given loop but also on its rotation (Figure 4). This represents the importance of considering the loop and not only its maximum vector to explain the ECG morphology.

*The positive and the negative hemifield of each lead are obtained by drawing lines perpendicular to each lead, passing through the centre of the heart. The positive hemifield is located in the area of positive part of the lead, and the negative hemifield in the negative part. In Figure 4 the positive hemifield is the area located between -90° and $+90^\circ$ passing through 0°, and the positive hemifield of lead VF is the area located between 0° and 180° passing through $+90^\circ$. The other part of the electrical field corresponds to the negative hemifield of each lead (see p. 10).

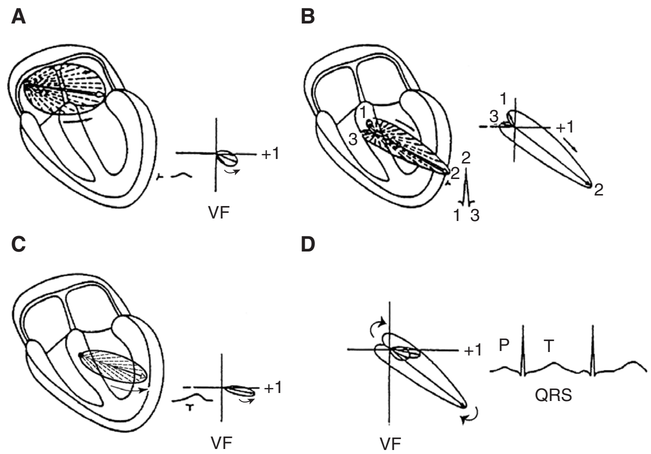

Figure 1 Three-dimensional perspective of the P loop (A), QRS loop with its three representative vectors (B) and T loop (C), and their projection on the frontal plane with the correlation loop–ECG morphology. (D) Global correlation between the P, QRS and T loops and ECG morphology on the frontal plane recorded in a lead facing the left ventricle free wall (lead I).

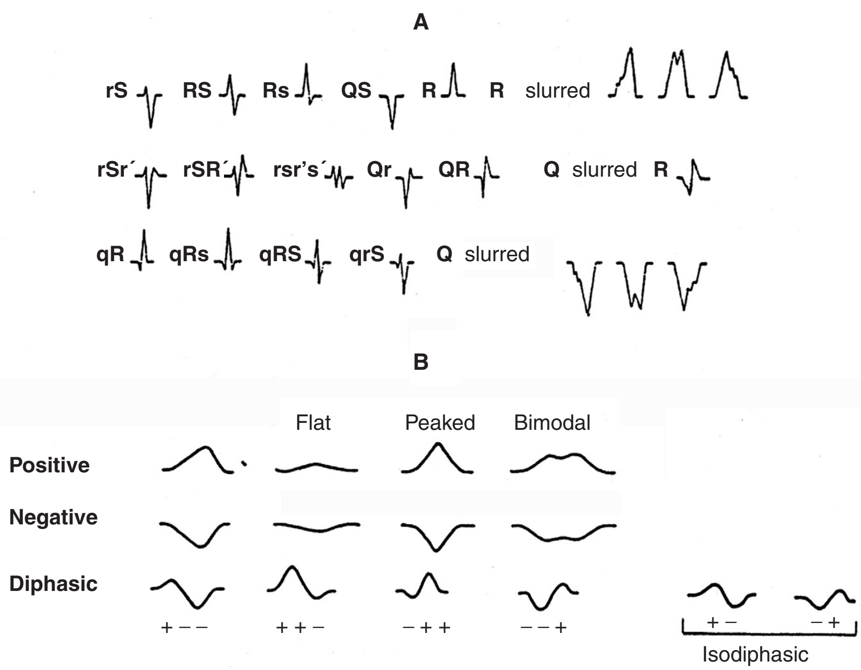

Figure 2 The most frequent QRS complex morphologies (A), P and T waves morphologies (B).

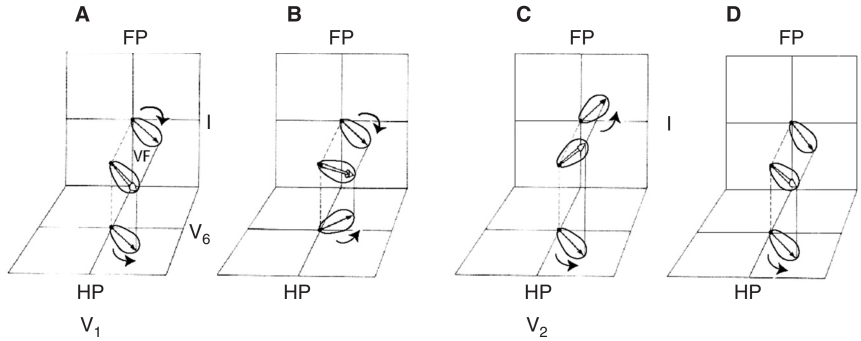

Figure 3 A loop with its maximum vector directed downwards, to the left and forwards (A) and another with its maximum vector directed downwards, to the left and backwards (B) have the same projections on the frontal plane (FP) but different projections on the horizontal plane (HP). On the other hand, a loop with the maximum vector directed upwards, to the left and forwards (C) and another with the maximum vector directed downwards, to the left and forwards (D) produce the same projection on the HP, but different projections on the FP.

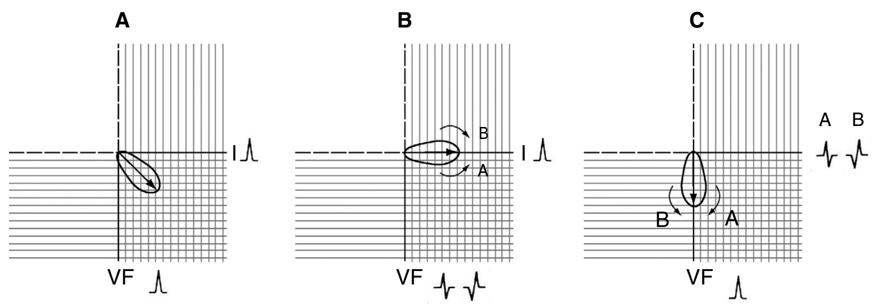

Figure 4 If the maximum vector of a loop falls in the limit of positive and negative hemifields of a certain lead, an isodiphasic deflection is recorded. However, according to the direction of loop rotation the QRS complex may be positive–negative or negative–positive (see examples for leads VF and I in the case of maximum vector directed to 0° (B) and +90° (C)). The loop with maximum vector at 45° (A) always fails in the positive hemifield of I and VF, independently of the sense of rotation.

VCG is rarely used in current clinical practice; however, it is highly useful in understanding ECG morphologies and in teaching electrocardiography. Later in this book we will explain in more detail how the loops originate and how their projection in frontal and horizontal planes explains the ECG morphologies in different leads.