PART 2
Abnormal electricity of the heart

4 • Recognising and understanding ectopia

Arrhythmia and dysrhythmia are synonymous terms, meaning an abnormal rhythm. Arrhythmias include abnormalities in rate, abnormalities associated with ectopia and those associated with abnormalities in conduction. Arrhythmias that are essentially slow are referred to as **bradyarrhythmias**, and those that are fast as **tachyarrhythmias**.

First identify the morphology of the normal QRS complex

Chapter 2 explained the formation of a normal sinus complex. It is important when examining an ECG tracing to identify (from the ECG recording) the normal sinus complex for that animal. Note the shape of the ventricular depolarisation and repolarisation waves, i.e. the QRS complex and T wave. To produce this shape of QRS and T, depolarisation of the ventricles has occurred by conduction from (or through) the AV node, i.e. ventricular depolarisation has been initiated from the AV node (see Chapter 2). It is of paramount importance in any tracing, especially if there are a variety of shapes of QRS complexes, to determine which shape represents conduction that has arisen (correctly) via the AV node.

The morphology of an ectopic ventricular depolarisation

Any QRS–T complex, therefore, that is of a different shape (from the QRS–T of a normal sinus complex *for that animal*) represents an abnormality. When the QRS–T complex is different from the normal sinus complex, depolarisation has (*almost certainly*) not arisen via the AV node (which would have produced a normal QRS shape) but from an ectopic location in the ventricles. Additionally these ventricular ectopic complexes are not associated with a preceding P wave (except by coincidence).

From Fig. 4.1a it can be seen that the direction of ventricular depolarisation is different from the direction that would have occurred from depolarisation arising from the AV node (cf. Figs 2.4–2.6). In this example the ventricular ectopic depolarisation wave is away from the +ve electrode and is therefore displayed on the ECG paper as below the baseline, i.e. the QRS complex is negative (Figs 4.1b, c). Secondly, because conduction has not travelled through the normal (therefore fast) electrical conduction tissue (it has depolarised the ventricular muscle mass from 'cell to cell') the time it takes to depolarise the ventricles is prolonged. Thus, not only is the QRS complex of the ventricular ectopic different in shape, but it is also prolonged (it takes a longer time). Quite often the T wave following the QRS complex of a ventricular ectopic is large and opposite in direction to the QRS.

Ventricular ectopic complexes can arise from any part of the ventricles and thus the direction in which they depolarise the ventricles is variable. To put it another way, since the direction in which the depolarisation wave travels in relation to the +ve electrode is variable, the shape and magnitude of the QRS complex of a ventricular complex will also be variable (Fig. 4.2a).

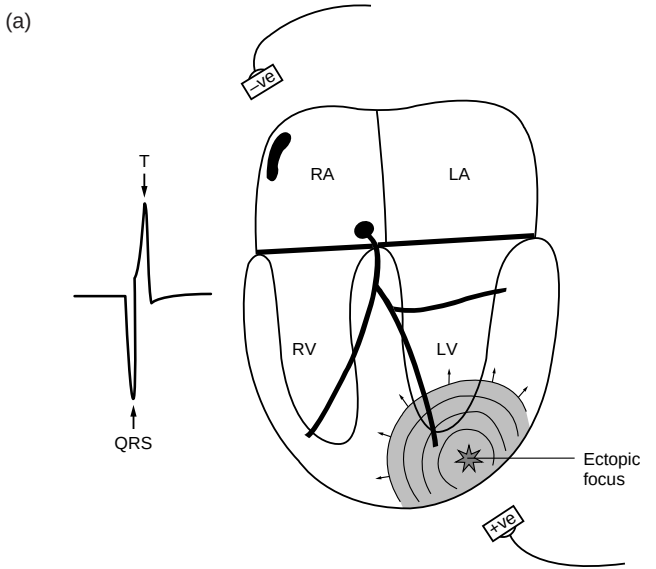

Figure 4.1 (a) Diagram illustrating an ectopic focus with the spreading out of the depolarisation wave (*left*), and the formation of a QRS–T complex (*right*) associated with the ventricular ectopic. RA – right atrium; LA – left atrium; RV – right ventricle; LV – left ventricle.

The important point is that the QRS of a ventricular ectopic complex is different from the QRS complex of one that has arisen from the AV node and travelled normally down the electrical conducting tissue to the ventricles (Fig. 4.2b, c).

A ventricular ectopic complex can occur quickly (or early) and is therefore termed a **ventricular** *premature* **complex** (VPC). If a ventricular ectopic occurs after a pause (or with delay) then it is referred to as a **ventricular** *escape* **complex** (Fig. 4.3).

Key points

- First identify the morphology of the normal QRS complex for the animal.
- The QRS of a ventricular ectopic complex is different from the QRS complex of one that has arisen from the AV node.
- Ventricular ectopic complexes are not associated with a preceding P wave (except by coincidence).

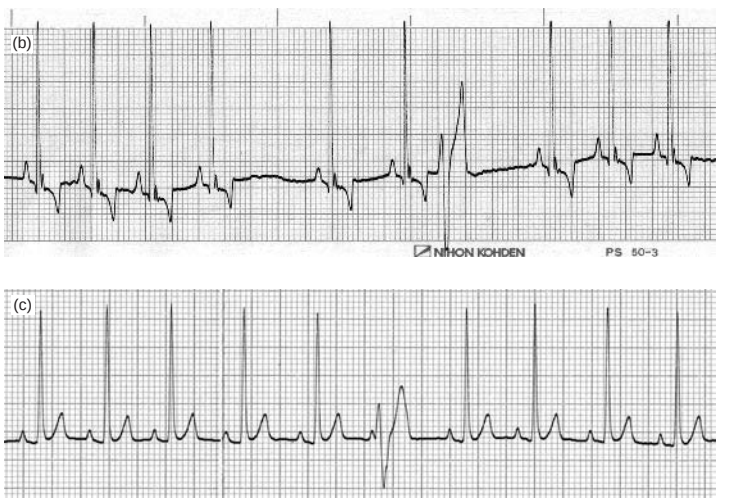

Figure 4.1 (b, c) ECGs from dogs each showing one VPC in which the QRS morphology has a negative morphology with an opposite and positive T wave morphology (25 mm/sec and 10 mm/mV).

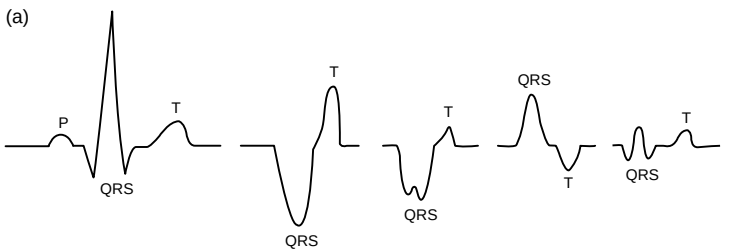

Figure 4.2 (a) Illustration of a normal complex (first complex), followed by four examples of QRS–T complexes with an abnormal morphology due to ventricular ectopic depolarisations. It is paramount to identify the morphology of the QRS complex associated with a sinus complex (first complex). Any QRS complexes of a different morphology (for that animal) must arise from an ectopic ventricular focus.

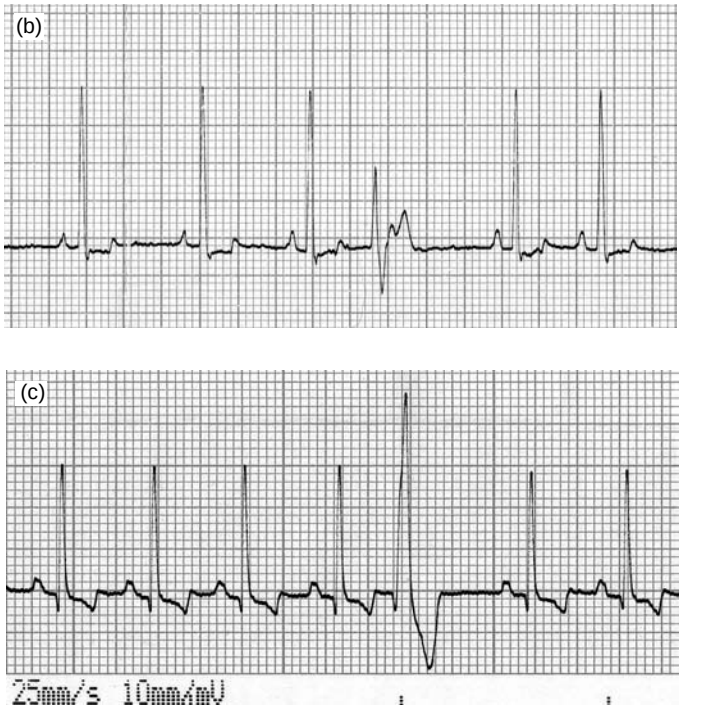

Figure 4.2 (b, c) ECGs from dogs each showing one VPC in which the QRS morphology is not negative (cf. Fig. 4.1), but of differing morphologies. The fact that they are different from the morphology of the normal sinus QRS complexes is important in recognising that they are ventricular in origin, as well as being premature (25 mm/sec and 10 mm/mV).

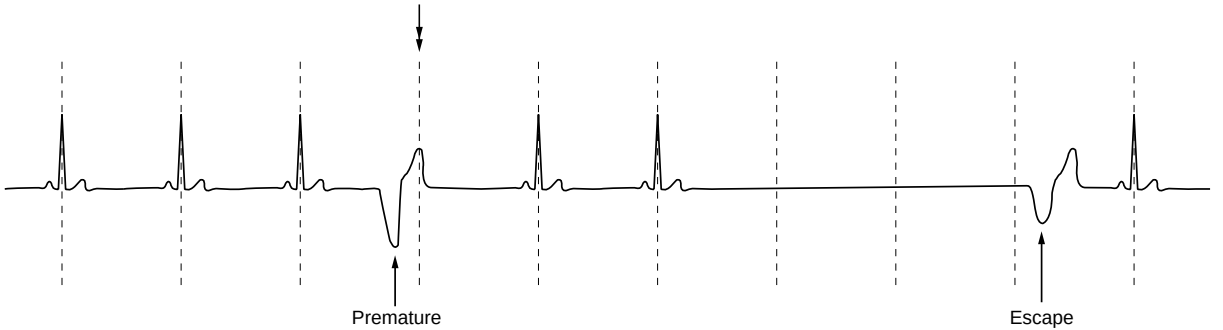

Figure 4.3 Illustration of (1) a ventricular premature complex (the double-headed arrow indicates the timing of when the next normal sinus complex would have occurred) and (2) a ventricular escape beat that occurred following a pause in the rhythm.

The morphology of an ectopic supraventricular depolarisation

Any ectopic stimuli arising above the ventricles are referred to as supraventricular (Fig. 4.4). These can be divided into two categories: (1) those occurring in atrial muscle mass (atrial ectopics) and (2) those arising from within the AV node (junctional or nodal ectopics).

No matter where supraventricular ectopics arise, they must travel down the normal His–Purkinje tissue and depolarise the ventricles as normal. Thus, the morphology of the QRS complex associated with a supraventricular ectopic is normal,[1] i.e. the same as the QRS complex for a sinus complex. This means that the identification of a supraventricular ectopic can be difficult. In the vast majority of cases however, it occurs as a premature beat, and so it is primarily recognised by its premature timing (Fig. 4.5a, b).

Whether an ectopic arose from the atria (**atrial premature complex**) or the AV node (referred to as a **junctional or nodal premature complex**) is of little practical importance in small animals until studying advanced ECGs. Additionally, in small animals it does not often affect the management or treatment in the vast majority of cases. Therefore, distinguishing between atrial and junctional premature complexes will not be discussed in this book, but will be referred to by the broader term of **supraventricular premature complexes** (SVPCs).

Key points

- The morphology of the QRS complex associated with a supraventricular ectopic is the same as a normal sinus complex.
- It is primarily recognised by its premature timing.

Terminology

The electrocardiographic interpretation of arrhythmias due to ectopia requires an understanding of the terminology used. If this is accomplished, interpretation becomes relatively easy.

[1] Except when there is aberrant conduction, see Chapter 10. However this is not common.

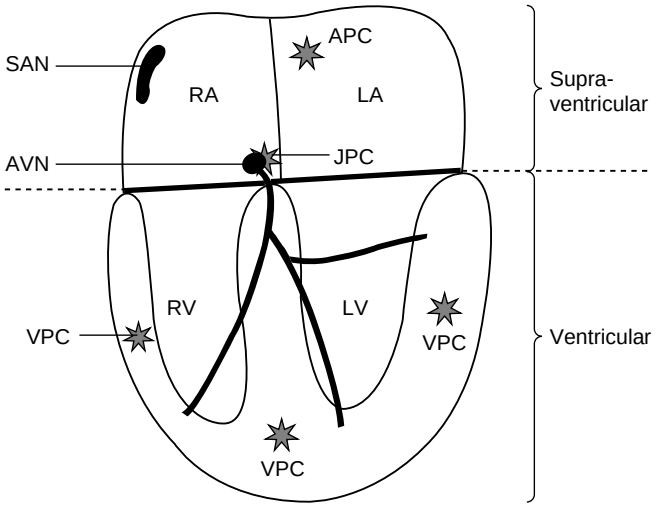

Figure 4.4 Illustration of the origin of supraventricular and ventricular ectopic complexes. SAN – sinoatrial node; AVN – atrioventricular node; APC – atrial premature complex; JPC – junctional premature complex; VPC – ventricular premature complex; RA – right atrium; LA – left atrium; RV – right ventricle; LV – left ventricle.

The term 'beat' implies that there has been an actual contraction. In 'ECG-speak' it is better to use the term **complex** or **depolarisation** to describe waveforms on the electrocardiograph.

Ectopic complexes may be classified by the following:

(1) *Site of origin* (Fig. 4.4). They are either ventricular or supraventricular. Supraventricular ectopics may be subclassified into either: (a) atrial (originating in the atria) or (b) junctional or nodal (originating in the AV node or bundle of His).

(2) *Timing*. Ectopic complexes that occur before the next normal complex would have been due are termed **premature**, and those that occur following a pause such as a period of sinus arrest or in complete heart block are termed **escape** complexes (Fig. 4.3).

(3) *Morphology*. If all the ectopics in a tracing have a similar morphology to each other they are referred to as **uniform** and those in which there are different shapes are termed **multiform** (Fig. 4.6).

(4) *Number of ectopics*. Premature ectopic complexes may occur singly, in pairs (Fig. 4.7), or in runs of three or more; the latter is referred to as a **tachycardia**. A tachycardia may be continuous, termed **persistent** or **sustained**, or intermittent, termed **paroxysmal**.

(5) *Frequency*. The number of premature ectopic complexes in a tracing may vary from occasional to very frequent. When there is a set ratio such as one sinus complex to one ectopic complex it is termed **bigeminy** (Fig. 4.8) and one ectopic to two sinus complexes is termed **trigeminy**.

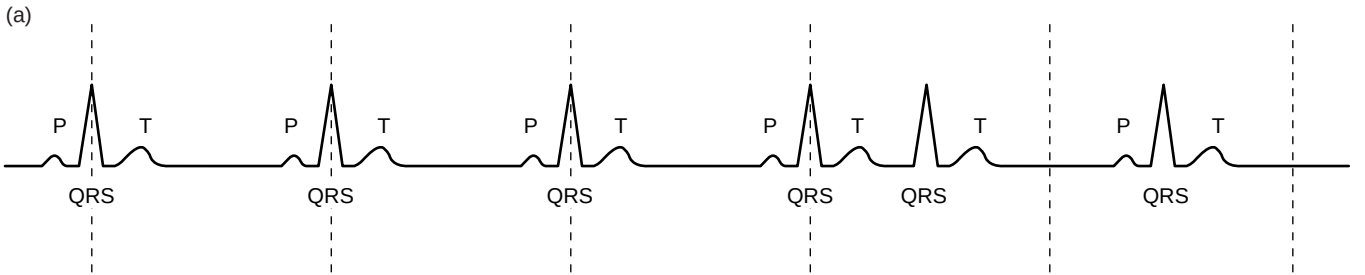

Figure 4.5 (a) Illustration of a supraventricular premature complex (fifth beat).

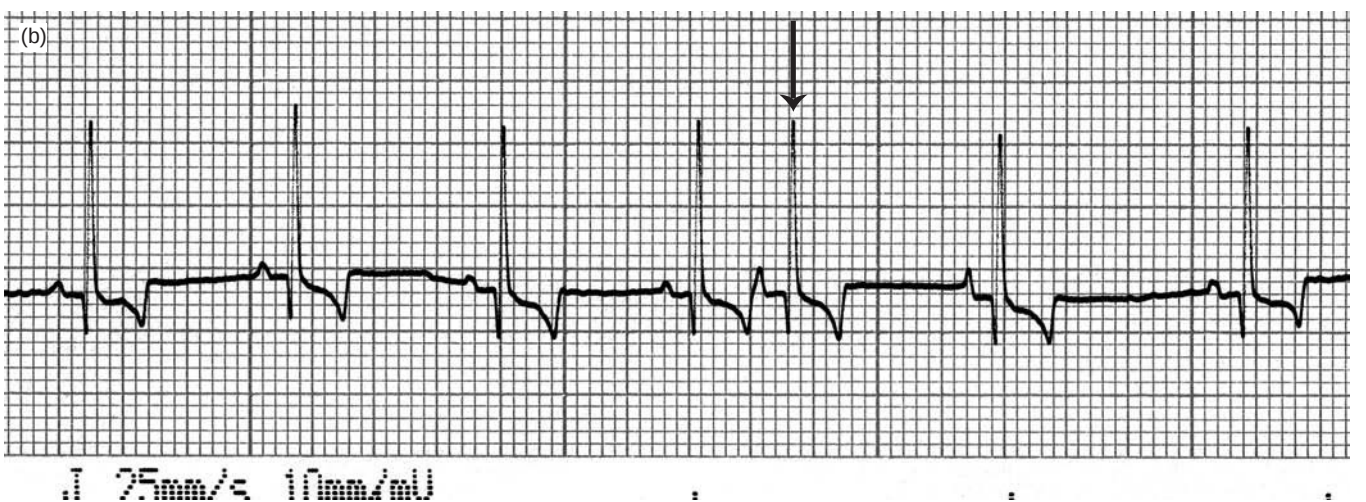

Figure 4.5 (b) ECG from a dog showing a supraventricular premature complex (arrowed). Note that the recognition is by its prematurity, as its QRS and T morphology is the same as a normal sinus complex (25 mm/sec and 10 mm/mV).

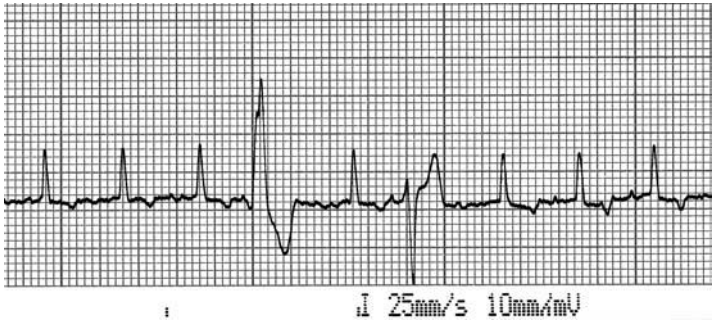

Figure 4.6 ECG from a dog showing two VPCs of differing morphologies: the first with a positive QRS and the second with a negative QRS. These VPCs are very likely to have arisen from different foci in the ventricles. This ECG tracing is described as having multimorphic VPCs (25 mm/sec and 10 mm/mV).

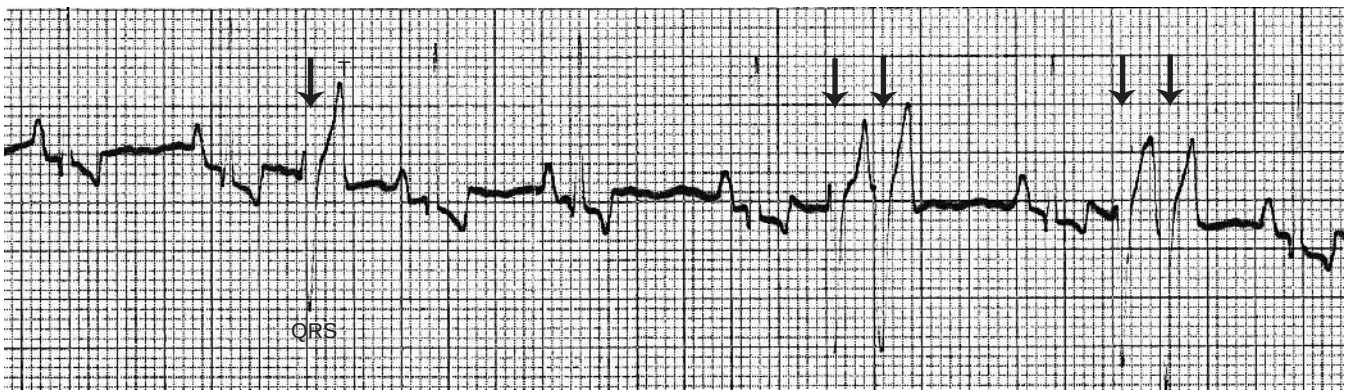

Figure 4.7 ECG with ventricular premature complexes (arrows), singly and in pairs. From a German Shepherd dog with a splenic mass (25 mm/sec and 10 mm/mV).

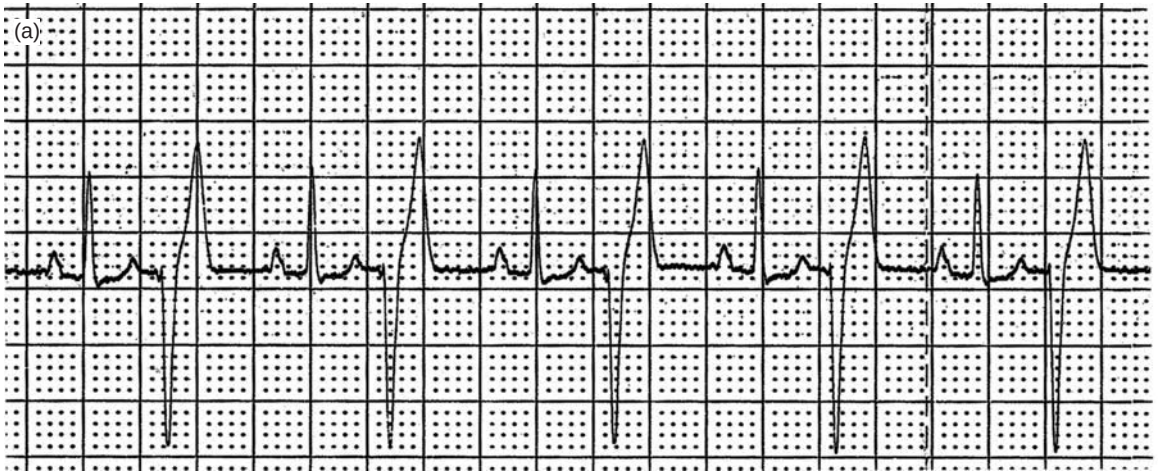

Figure 4.8 (a) ECG with ventricular premature complexes that alternate with normal sinus complexes; this is termed ventricular bigeminy. From a 13-year-old Standard Poodle with mitral valve disease (25 mm/sec and 5 mm/mV).

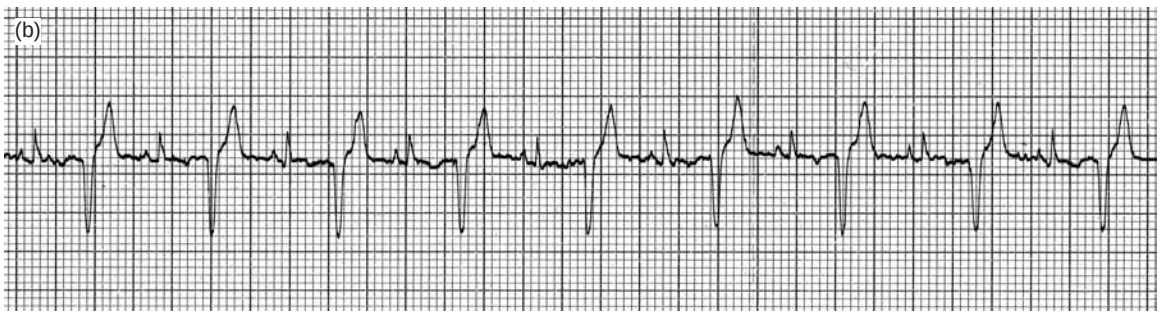

Figure 4.8 (b) ECG from a cat with hypertrophic cardiomyopathy showing a ventricular bigeminy (25 mm/sec and 10 mm/mV).