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Arrhythmias: Recognition and Treatment

Anne French MV, CertSAM, DVC, DipECVIM-CA(Cardiology), MRCVS, FHEA
Hospital for Small Animals, Easter Bush Veterinary Centre, Roslin, Midlothian EH25 9RG, UK

Arrhythmia can be divided into disturbances in impulse formation and impulse conduction which may result in bradyarrhythmias or tachyarhythmias. This lecture will focus on the identification of arrhythmias and the treatment options.

Recognition of arrhythmias

Disturbances of sinus impulse formation

Sinus arrest

Sinus arrest is a period where there is no evidence of atrial activity for a period in excess of the two preceding R - R intervals, and implies that there is a depression in automaticity within the sinus node. It is usually recognised in dogs with high vagal tone such as brachycephalic dogs or dogs with underlying respiratory disease. Periods without evidence of any sinus node activity may be prolonged enough to result in syncope. Sinus bradycardia

May be a normal rhythm. It may also be recognised in patients with hypothermia, hyperkalaemia, CNS lesions, or drug related eg digoxin, opioids, betablockers, calcium channel antagonists.

Atropine response test

If these bradyarrhythmias are genuinely related to high vagal tone, they should be easily abolished by the administration of atropine. The recommended protocol is to record an ECG trace, then administer atropine (0.04 mg/kg by subcutaneous injection) and after 30 minutes record a further ECG trace.

Sinus tachycardia

Sinus tachycardia is probably the most common rhythm detected in small animal cardiac patients due to the excited state of most patients. Animals with incessant tachycardia may well have underlying congestive heart failure with high sympathetic drive. Animals in pain or with pyrexia may also show a persistent sinus tachycardia.

Disturbances of supraventricular impulse formation

Supraventricular premature complexes (SVPC)

These are supraventricular complexes that occur early and arise from a focus in the atria or the AV node junctional area rather than from the sinus node. The P waves may be positive, negative or hidden in the QRS complexes. The QRS complexes are narrow upright complexes in lead II and look similar to the sinus complexes.

Supraventricular tachycardia (SVT) - atrial or junctional

This is characterized by a tachycardia where the P wave configuration differs from the sinus P waves. The rate is rapid. The QRS morphology is normal. The rhythm is regular unless a multifocal tachycardia is present. The origin may be atrial or junctional. In junctional tachycardia an ectopic focus in the AV junction acts as the primary pacemaker. The P waves are usually inverted and may precede, be superimposed on or follow the QRS complex. It is frequently impossible to differentiate atrial tachycardia from a junctional tachycardia. SVT may be paroxysmal or sustained.

Atrial fibrillation (AF)

Is recognised by an irregular chaotic ventricular rhythm. In the majority of cases there are no recognisable P waves preceding the QRS complex. Sometimes fine irregular movements of the baseline are seen as a result of the atrial fibrillation waves - referred to as F waves. They may be indistinguishable from baseline artefact. The ventricular rate in dogs and cats is nearly always fast, as most cases are in congestive heart failure and therefore there is a compensatory sympathetic drive. Slower rates are sometimes seen in the giant breed dogs.

Attrial flutter

Is seen as a rapid and regular, ‘saw toothed’ type movement of the baseline, at a rate of 300 - 500/min. These are referred to as F waves; the QRS complexes are normal, and occur at a more normal and regular heart rate, often at a set frequency to the F waves.

Disturbances of ventricular impulse formation

Ventricular premature beats (VPC)

These beats occur early. They are not related to a P wave and they are usually wide and bizarre in appearance. If they originate high up in the interventricular septum they may have a narrow upright conformation and may be confused with a supraventricular premature complex.

Ventricular tachycardia (VT)

Ventricular tachycardia is a continuous series of VPCs resulting from stimulation of an ectopic ventricular focus. It may be intermittent or persistent. Ventricular tachycardia may be a life threatening arrhythmia. The ventricular rate is usually above 160 bpm. A ventricular rhythm between 100 - 160 bpm is termed an idioventricular rhythm. P waves that are seen are of normal configuration. There is no relationship between the P waves and the QRS complexes. The P waves may precede, follow or be hidden in the QRS complexes. QRS complexes are wide and bizarre. Ventricular fusion and capture complexes occur commonly in ventricular tachycardia.

Ventricular fibrillation (VF)

This is a nearly always a terminal effect, and causes

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cardiac arrest. The depolarisation waves occur randomly throughout the ventricles. There is therefore no significant co-ordinated contraction to produce any cardiac output. If the heart is visualised, fine irregular movements of the ventricles may be seen. The ECG shows coarse (larger) or fine (smaller); rapid, irregular and bizarre movement; no normal wave or complex can be seen. VF often follows ventricular tachycardia.

**Disturbances of impulse conduction**

**Sinus block**

Sinus block is diagnosed where there is no P wave for a duration equal to the two preceeding R - R intervals. Like sinus arrest it is usually recognised in dogs with accentuated sinus arrhythmia, often those with high vagal tone such as brachycephalic dogs or dogs with underlying respiratory disease.

**Atrioventricular (AV) block**

Atrioventricular (AV) block describes an abnormality affecting conduction from the normally depolarized atria to the ventricles. The block occurs at the level of the AV node or the bundle of His.

- **1st degree:** In first degree AV block, conduction across the AV node or the bundle of His is merely slowed - the P-R interval is thus prolonged.
- **2nd degree:** In second degree AV block, some of the atrial depolarisation (P wave) does not result in a QRS complex - i.e. the P:QRS ratio is >1:1. The P - R interval may be variable, usually tendng to increase prior to the block (Mobitz type I; the Wenckebach phenomenon) - this is another manifestation of high vagal tone. In other cases of second degree AV block, there is a constant P - R interval. This is Mobitz type II block and is generally more serious, indicating disease of the conduction system.
- **3rd degree:** In third degree AV block, none of the P waves are responsible for ventricular depolarisation. There tends to be a constant and regular P rate, and the ventricular rate depends upon functional or ventricular escape or rescue beats. The overall ventricular rate is slow. The shape of the ventricular escape complexes will depend on where they originate in the conduction system.

**Persistent atrial standstill**

Persistent atrial standstill is recognised with a slow regular escape focus and no evidence of atrial activity. No P waves can be identified on any lead system. The condition is seen with certain forms of muscular dystrophy. In the Siamese cat and some breeds of dogs atrial standstill is seen without any skeletal muscle involvement. Hyperkalemia produces a temporary reversible atrial standstill.

**Atrioventricular dissociation**

This term refers to complete dissociation of the atria and ventricles. The atria and ventricles are being excited by two separate and independent foci. Usually normal sinus node activity depolarises the atria and a junctional rhythm depolarises the ventricles. There is no regular P-R interval. On ECG, P waves appear to wander in and out of the QRS complexes.

**Disturbances of impulse formation and conduction**

**Sick sinus syndrome (SSS)**

Sick sinus syndrome may result in a variety of ECG abnormalities. The syndrome probably should be called sick conduction syndrome as the sinus node, AV node and escape rhythms are all affected. A variety of arrhythmias are seen including sinus bradycardia, sinus arrest with no escape rhythm, AV block and paroxysmal episodes of supraventricular tachyarrhythmias.

**Ventricular pre-excitation and supraventricular tachycardia**

In ventricular preexitation, an atrial bypass tract outside the AV junction connects the atrium to the ventricle circuiting the AV node, which results in premature activation of the ventricles. An abnormally short P-R interval is seen on the ECG. If the bypass tract circumvents both the AV node and the bundle of His early activation of the ventricles causes a slurring of the upstroke of the QRS, called a (delta) wave. Retrograde conduction may result in supraventricular paroxysmal tachycardia due to a reentry mechanism. This is called the Wolff-Parkinson-White syndrome (WPW).

**Escape rhythms**

**Escape beats**

In general, the escape beats apparent in the various bradyarrhythmias look like ventricular premature complexes, as they arise from a similar focus. However they are not premature; they are late or escape complexes and should never be suppressed.

**Treatment of arrhythmias**

**Bradyarrhythmias**

Animals with bradyarrhythmias such as sinus arrest, sinus bradycardia, 2nd or 3rd degree AV node block, atrial standstill, sick sinus syndrome should be carefully checked for electrolyte imbalances, systemic disease causing high vagal tone or history of drug ingestion. Bradyarrhythmias due to high vagal tone may respond to medication with vagolytic or sympathomimetic drugs. If there is no response to medication then pacemaker implantation is the only option.

- **Vagolytic drugs:** atropine, robantheline, glycopyrrolate
- **Sympathomimetic drugs:** isoprenaline, terbutaline, methylxanthines
- **Other:** pacemaker implantation

**Tachyarrhythmias**

It is important to remember that drugs used in the treatment of tachyarrhythmias, with the exception of digoxin, are all negative inotropes and should be used...
with caution in the presence of congestive heart failure (Table 1).

**Further reading**


### Table 1: Drugs used for the treatment of tachyarrhythmias

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>Species</th>
<th>Drugs</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus tachycardia, Supraventricular tachycardia</td>
<td>dogs</td>
<td>Digoxin, beta-blockers, calcium channel blockers</td>
<td>Vagal maneuvers may disrupt sustained SVT. Drugs may disrupt or just slow supra-ventricular tachycardia. WPW can be treated by radiofrequency ablation</td>
</tr>
<tr>
<td></td>
<td>cats</td>
<td>Calcium channel blockers, beta-blockers</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>dogs</td>
<td>Digoxin +/- beta-blockers if HR&gt;160 +/- calcium channel blockers</td>
<td>In dogs and cats usually the object of therapy is to slow the ventricular response rate, not to convert to sinus rhythm. Some recent cases may convert with amiodarone or electroconversion.</td>
</tr>
<tr>
<td></td>
<td>cats</td>
<td>Calcium channel blockers, beta-blockers</td>
<td></td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>dogs</td>
<td>i/v lignocaine then oral procainamide/tocainide/mexiletine/beta-blocker</td>
<td>The aim of therapy is to convert to sinus rhythm. Refractory cases may respond to sotalol or amiodarone.</td>
</tr>
<tr>
<td></td>
<td>cats</td>
<td>beta-blocker</td>
<td></td>
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