Diagnosis and management of supraventricular tachycardias

Supraventricular tachycardias (SVTs) are rhythm disturbances arising within the sinus node, the atrial tissue or the atrioventricular node. They are characterized by narrow QRS complex morphology on an electrocardiogram (ECG) and rapid heart rate. A correct diagnosis is essential for treatment and can sometimes be challenging as different rhythm disturbances may have a similar appearance on the surface ECG. This article reviews the main characteristics of the most common SVTs and describes a useful approach for their differential diagnosis.

Key words: electrocardiography, supraventricular tachycardia, atrial fibrillation, atrial flutter, atrial tachycardia, Holter, electrophysiology.

Introduction

Supraventricular tachycardia (SVT) is a term used to describe a rhythm disturbance arising above the bundle of His and causing a pathological tachycardia. The focus of origin may be located within the sinus node, the atrial tissue and the atrioventricular (AV) node (Figure 1).

Mechanisms of arrhythmogenesis include abnormal impulse formation and/or impulse conduction:

Disorders of impulse formation

These are caused by increased automaticity of the normal cardiac pacemakers, development of automaticity in non-pacemaker cells and oscillations of the resting membrane potential that lead to depolarization (triggered activity).

Disorders of impulse conduction

These may occur as a consequence of abnormal automatic tone or due to structural abnormalities (areas of fibrosis or ischemia, abnormal bands of excitable tissue - accessory pathways) predisposing to re-entrant arrhythmias (i.e. re-entry of an impulse back to an area of the heart that was previously depolarised).

Incidence of SVTs

SVTs are common rhythm disturbances in clinical practice. They most frequently occur in animals with structural heart disease or severe concurrent systemic illness such as neoplasia, endocrinopathies, metabolic or electrolyte abnormalities but may also be idiopathic. They can be challenging both in terms of making a diagnosis from the surface electrocardiogram and also pharmacological management. These tachyarrhythmias may be accompanied by haemodynamic instability requiring immediate treatment and, if sustained, there is also a risk of tachycardia induced cardiomyopathy. Syncope is an uncommon presenting sign with intermittent SVT – some dogs may be asymptomatic, some may exhibit behavioural change such as panting or exercise intolerance, and some may present with congestive heart failure.

Sinus tachycardia

Sinus tachycardia is characterized by an increase of the discharge rate of the sinus node following physiologic (increased sympathetic stimulation due to exercise/excitement) or pathological stimuli (low output cardiac diseases, congestive heart failure, hypotension, hypoxia, anaemia, pain). It is challenging to define a specific threshold heart rate for these cases – instead it is best to interpret the rate in light of the patient’s size, age, temperament and fitness. Sinus tachycardia is characterized by positive P waves in leads II, III and aVF with a normal PQ interval, similar morphology to the sinus P wave and a gradual onset and offset of the tachycardia with an initial speeding and final slowing of the heart rate (“warm-up” and “cool-down” phenomenon) (Figure 3).

Treatment is not usually required as this is an appropriate physiological rhythm but, if persistent or if the rate is inappropriate,
then further investigation may be required to determine if there is underlying cardiac and/or systemic disease.

**Atrial Fibrillation**

Atrial fibrillation (AF) is one of the most common arrhythmias in veterinary medicine. It is characterized by rapid, disorganized atrial electrical activity (frequently above 300 bpm) that results in loss of the atrial contribution to ventricular filling and an irregular and typically rapid ventricular contraction rate that leads to reduction of the cardiac output. The majority of dogs and cats with AF have concurrent cardiac disease and severe atrial enlargement. Occasionally AF is diagnosed in the absence of underlying overt structural heart disease and this occurs most often in large and giant breed dogs.

The ECG in AF is characterized by a lack of identifiable P waves, undulations of the baseline (fibrillatory "F" waves), narrow QRS complexes (<70 msec in dogs and <40 msec in cats) and irregular ventricular rhythm with a variable R-R interval (Figure 4). Occasionally the QRS complexes are conducted with a bundle branch block and may present with a wide and bizarre morphology resembling ventricular tachycardia (Figure 5).

If atrial fibrillation is detected then echocardiography is indicated to assess cardiac chamber dimensions. Thoracic radiographs may be useful in determining whether there is evidence of congestive heart failure. Treatment in dogs with chronic atrial fibrillation and/or significant structural heart disease is generally aimed at controlling the ventricular rate rather than conversion back to sinus rhythm. Drugs commonly used to control the ventricular rate include diltiazem and/or digoxin but other medications may be required in certain situations and discussion with a veterinary cardiologist is advisable due to the potential risks of drug toxicity.

**Atrial Flutter**

Atrial flutter is a very rapid but organized cardiac arrhythmia characterized by fast atrial rate (usually between 200 and 400 bpm). It is caused by a macro re-entrant single circuit that repetitively depolarizes the atria. Re-entrant circuits can occur due to reduced conduction velocity in different areas of the heart as a consequence of myocardial stretch, fibrosis, scarring or other functional or anatomical barriers. In the dog typically the circuit involves the right atrium and more specifically the caudal and cranial vena cava, the tricuspid...