A 9.0-kg (19.8-lb) adult castrated male Silky Terrier was evaluated because of an arrhythmia recently identified prior to a left cranial cruciate ligament rupture repair. The dog was adopted approximately 3 years prior as an adult dog and was estimated to be approximately 7 years of age. The dog had no clinical signs, particularly no evidence of weakness or collapse, at home. The dog was not receiving any medications other than tick and flea preventative on a monthly basis. A single lead II ECG tracing obtained by the dog’s regular veterinarian revealed short paroxysms of atrial premature contractions (APCs; data not shown). At the initial referral evaluation, 6-lead ECG was performed (Figure 1).

**ECG Interpretation**

The 6-lead ECG tracing revealed that the underlying rhythm was regularly irregular (Figure 1). Initially, there were periods of tachycardia with a heart rate of approximately 180 beats/min; heart rate then slowed to approximately 60 beats/min with evidence of sinus arrest. The P-wave morphology varied, suggestive of a wandering pacemaker. There was no evidence of any APCs on the ECG tracings obtained at the referral hospital. Echocardiography was performed, which identified a 2.23 × 1.27-cm hypoechoic solitary mass associated with the free wall of the right atrium and involving the tricuspid valve apparatus. In addition, there was hyperechoic material oscillating between the right atrium and right ventricle that did not appear attached to the mass. The echocardiogram was assessed as most consistent with a right atrial hemangiosarcoma and intracardiac thrombus. Owing to the suspected intracardiac thrombus, an atropine response test was not performed.

**Discussion**

A wandering pacemaker is defined as variability in morphology and amplitude of the P waves over time.1,2 This is a common ECG finding in dogs and results from a shift in the site of depolarization from the sinus node along the terminal crest of the right atrium toward or occasionally to the atrioventricular node.2 This causes alteration of the depolarization pathways through the atria and resultant changes in P-wave morphology.2 A wandering pacemaker is often evident with respiratory sinus arrhythmia, and both phenomena are associated with an increase in vagal tone.3

Atrial premature contractions are premature supraventricular impulses initiated from sites outside the sinus node.1,2 In dogs, APCs usually occur secondary to atrial enlargement from myxomatous mitral valve disease or dilated cardiomyopathy.1,2 In rare instances, APCs can occur secondary to myocardial damage induced by a primary cardiac neoplasm, as was suspected in the dog of the present report.

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Figure 1—Six-lead ECG tracing obtained from a dog that was referred for evaluation because of an arrhythmia recently identified prior to a left cranial cruciate ligament rupture repair. The dog had no known clinical signs of cardiac abnormalities. Notice the mild variation in P-wave morphology and the accelerating and decelerating heart rate suggestive of a sinus arrhythmia. The second pause exceeds 2 R-R intervals combined, which is consistent with a period of sinus arrest. Paper speed = 50 mm/s; 1 cm = 1 mV.
Sinus arrest is defined as an absence of atrial activity for a period in excess of the 2 preceding R-R intervals combined. It usually implies a depression in automaticity within the sinus node, which can be secondary to high vagal tone or intrinsic dysfunction of the sinus node. Given the periods of sinus arrest and historical APCs, sick sinus syndrome was considered a differential diagnosis for the dog described. Sick sinus syndrome reportedly most commonly affects Cocker Spaniels as well as Miniature Schnauzers, West Highland White Terriers, Pugs, and Dachshunds. The ECG abnormalities identified in dogs with sick sinus syndrome include sinus bradycardia, sinoatrial block, sinus arrest, and paroxysms of supraventricular tachycardia. Often, the atrioventricular node and bundle branches are also dysfunctional, resulting in atrioventricular or bundle branch block as well. The dog of the present report had many of the ECG abnormalities indicative of sick sinus syndrome, and it was presumed that if the mass that was associated with the free wall of the right atrium and infiltrated the sinus node, it could potentially precipitate sick sinus syndrome.

For the dog of the present report, another considered differential diagnosis was sinus arrhythmia, the most common cause of which is respiratory sinus arrhythmia. Respiratory sinus arrhythmia is a regular irregular rhythm with alternate slowing and acceleration of heart rate due to alterations in sympathetic and parasympathetic tone during respiration. Vagal cardiomotor neurons, under the influence of the central respiratory center, are inhibited during the inspiratory phase and activated during the expiratory phase of respiration. As the respiratory rate increases, the vagal effectors become less able to adjust to these higher-frequency respiratory variations and the respiratory sinus arrhythmia begins to diminish. During inspiration, the intrapleural pressure becomes more negative, causing the transmural pressure to increase, which results in expansion of the atria, ventricles, and vena cava. The expansion of the atria and ventricles stimulates stretch receptors in the respective chambers, which, under medullary activation of the sympathetic system, increases efferent activity to the sinoatrial node and increases the heart rate, which is known as the Bainbridge reflex. With expiration, the cardiac volume decreases, resulting in a reduction in heart rate as blood is forced from the pulmonary system. For the dog of the present report, respiratory sinus arrhythmia was considered less likely because of its heart rate.

An atropine response test could have been performed to differentiate the vaguely mediated sinus arrhythmia and nonvagally mediated sinoatrial exit block in the case described in this report. This test was not performed because of the presence of the suspected oscillating intracardiac thrombus. The finding of a right atrial mass in the dog of the present report was also unusual because masses associated with respiratory sinus arrhythmia are more commonly identified in large-breed dogs such as Afghan Hounds, German Shepherd Dogs, Golden Retrievers, and Labrador Retrievers. Right atrial hemangiosarcoma was considered most likely, as previous studies have reported that up to 88% of dogs with a right atrial mass detected via echocardiography receive a diagnosis of hemangiosarcoma after histologic examination of samples of the mass. The most common ECG abnormalities associated with right atrial masses in dogs include ventricular arrhythmias, supraventricular tachycardia, atrioventricular block, and right bundle branch block. Doxorubicin-based chemotherapy for the dog and elected treatment with airway dilators and the addition of aspirin administration for possible pulmonary thromboembolism. The dog was subsequently lost to follow-up.

References