A 12-year-old 1.90-kg (4.18-lb) castrated male Chihuahua was evaluated because of progressive lethargy and increased respiratory effort during the preceding 3 to 4 weeks. The dog had no history of episodes of collapse or prior medical problems. The dog had been eating and drinking apparently normally. Cardiac auscultation revealed a grade 3/6 left apical systolic heart murmur and a heart rate of 30 beats/min. Electrocardiography was performed, and findings were consistent with third-degree atrioventricular (AV) block (data not shown). On the basis of thoracic radiographic findings, the dog was initially suspected to have left-sided congestive heart failure. The dog was admitted to the hospital, and treatment with furosemide (3.125 mg, PO, q 12 h) and oxygen supplementation was initiated. The next day, the ECG examination was repeated (Figure 1).

ECG Interpretation

At 24 hours after hospital admission, a 6-lead ECG examination of the dog was performed (Figure 1). At this time, the atrial rate was approximately 120 beats/min and the ventricular rate was approximately 60 beats/min (Figure 2). The P-wave amplitude exceeded 0.4 mV, which was consistent with P-pulmonale and suggestive of right atrial enlargement. There was a slight depression of the baseline following all P waves, which represented atrial repolarization (called the T wave). The PR interval was consistent, which suggested that the atrial impulse was conducted through the AV node to the ventricles. The P′ wave was not followed by a QRS complex, which was consistent with a diagnosis of second-degree AV block with a 2:1 atrial-to-ventricular conduction rate. The P-P′ intervals that encompass a QRS complex are shorter than the P′-P intervals that do not encompass a QRS complex, a phenomenon termed ventriculophasic sinus arrhythmia. Paper speed = 25 mm/s; 1 cm = 1 mV.

Figure 1—Six-lead ECG tracings obtained from a dog 24 hours after admission to a hospital for evaluation of progressive lethargy and increased respiratory effort during the preceding 3 to 4 weeks. Paper speed = 25 mm/s; 1 cm = 1 mV.

Figure 2—Portion of the lead II tracing in Figure 1. Notice that the atrial rate is approximately 120 beats/min and the ventricular rate is approximately 60 beats/min. The P-wave amplitude is >0.4 mV, which is consistent with P-pulmonale and suggestive of right atrial enlargement. The slight depression of the baseline following the P waves represents atrial repolarization. The PR interval is consistent, suggesting that the atrial impulse is conducted through the AV node to the ventricles. The P′ wave is not followed by a QRS complex, which is consistent with a diagnosis of second-degree AV block with a 2:1 atrial-to-ventricular conduction rate. The P-P′ intervals that encompass a QRS complex are shorter than the P′-P intervals that do not encompass a QRS complex, a phenomenon termed ventriculophasic sinus arrhythmia. Paper speed = 25 mm/s; 1 cm = 1 mV.

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ventricular conduction rate. The P-P' interval that encompassed the QRS complex was shorter than the P'-P interval without the QRS complex. This phenomenon is termed ventriculo-phasic sinus arrhythmia.

Discussion

Atrioventricular block is defined as a delay or interruption in conduction of a supraventricular impulse through the AV junction and bundle of His when the AV junction is not physiologically refractory. For the dog of this report, a diagnosis of second-degree AV block was made, of which there are 2 types: type I and type II. Type I second-degree AV block (also called the Wenckebach phenomenon) is classically characterized by a progressive prolongation of the PR interval with successive beats until a P wave is blocked. Type II second-degree AV block is characterized by a fixed relationship in the PR interval prior to the blocked P wave. A normal QRS complex configuration can be suggestive of type I second-degree AV block, whereas an abnormal QRS complex configuration can indicate that type II second-degree AV block is present. In humans, the location of the block differs for the 2 types of second-degree AV block. Type I second-degree AV block with QRS complexes of normal appearance almost always occurs at the level of the AV node, proximal to the bundle of His. Type II second-degree AV block, particularly in association with a bundle branch block, is typically localized to the His-Purkinje system. It is uncertain whether a correlation between QRS morphology and lesion localization in the conduction system applies to dogs because results of 1 experimental study indicated that type I second-degree AV block may develop in dogs secondary to ischemia-induced pathological changes in the His bundle.

When there is a 2:1 atrial-to-ventricular conduction ratio, it is impossible to determine whether there is a progressive prolongation of the PR interval prior to the blocked P wave. Consequently, although second-degree AV block was identified in the dog of this report, we were not able to determine whether it was type I or II. Clinically, it is important to determine the type of second-degree AV block because type I can be a normal finding in some dogs and usually does not require treatment, whereas type II can progress to higher degrees of block and consequently requires treatment.

In the dog of this report, the right atrial enlargement suggested by the P-pulmonale was likely secondary to a combination of pathophysiologic consequences of AV block. During second- and third-degree AV block, the ventricular activation rate is lower than the rate when the ventricles are consistently activated by the sinus node. This creates a state of volume overload, which causes dilation of the cardiac chambers. In addition, with second- and third-degree AV block, there is a loss of AV synchrony and the atria periodically contract against a closed AV valve, causing intermittent increases in atrial pressure. These intermittent increases in atrial pressure have been reported to cause atrial enlargement in goats used in an experimental study as well as in humans with AV block.

Ventriculo-phasic sinus arrhythmia describes a phenomenon in patients with heart block in which variation in sinus rate occurs in relation to the QRS complexes. Classically, the P-P intervals that encompass a QRS complex are shorter than those that do not encompass a QRS complex. Ventriculo-phasic sinus arrhythmia may also develop with complete AV block or in the presence of ventricular premature complexes with a full compensatory pause.

The mechanism responsible for the occurrence of ventriculo-phasic sinus arrhythmia is unknown, but several mechanisms have been proposed. The most likely explanation appears to be that an increase in intra-atrial pressure following contraction excites the Bainbridge reflex, resulting in vagal inhibition with acceleration of sinus node discharge. Another proposed mechanism is that ventricular contraction results in an increase in coronary blood supply to the sinoatrial node, thereby accelerating sinoatrial node discharge. It suggests that ventricular contraction either shortens the duration of phase 4 of the sinoatrial node action potentials or decreases the conduction time from the sinoatrial node to the atria. Ventriculo-phasic sinus arrhythmia is a clinically insignificant arrhythmia, and for the dog of this report, treatment was directed towards the underlying AV block.

The dog underwent an echocardiographic examination the next day. Mild mitral and tricuspid valve regurgitation was detected; however, there was minimal left atrial enlargement and overall no evidence of left-sided congestive heart failure. Both the right atrium and right ventricle were dilated, the former consistent with the ECG findings of P-pulmonale. Pacemaker implantation was recommended to address the underlying rhythm because studies have revealed that the procedure is typically well tolerated and duration of survival for dogs with high-grade second- or third-degree AV block is improved subsequent to pacemaker implantation. However, this option was declined by the owners and the dog was discharged from the hospital; the owners were instructed to administer doxycycline (10 mg, PO, q 12 h) and theophylline (16 mg, PO, q 12 h). On subsequent recheck examinations of the dog at 1 week, 2 months, and 4 months after discharge from the hospital, consistent high-grade second-degree and periodic third-degree AV block was detected. However, the dog remained minimally affected other than mild exercise intolerance.

References


