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ECG of the Month

A 17-year-old 4.59-kg castrated male domestic medium-hair cat was presented for a recheck cardiac evaluation of previously diagnosed second-degree atrioventricular (2° AV) block (atropine responsive) and idiopathic systemic hypertension (well controlled with amlodipine, 1.25 mg, PO, q 24 h). An arrhythmia was auscultated on physical examination, and echocardiography revealed mild hypertrophic cardiomyopathy with no evidence of chamber enlargement. Six-lead ECG was performed **(Figure 1)**.

ECG Interpretation

The ECG tracing revealed an underlying sinus rhythm. Narrow QRS complexes were followed by a single wide QRS complex with a consistent PR interval and deep S wave in leads II, III, and aVF, consistent with a right bundle branch block (RBBB).[1] An initial wide QRS complex is followed by a blocked P wave, suggestive of 2° AV block, and then subsequent, successive wide QRS complexes were followed by a blocked P wave, again consistent with 2° AV block. Prior to each blocked P wave, there was a constant PR interval, as with Mobitz type II 2° AV block. The development of transient RBBB in association with a change in ventricular rate produced by the 2° AV block was consistent with aberrant conduction. The diagnosis was sinus rhythm with Mobitz type II 2° AV block with linking phenomenon.

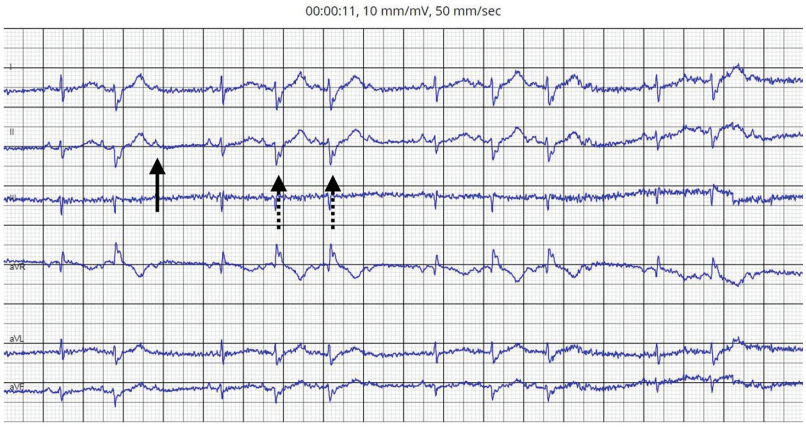

Figure 1—Six-lead ECG tracing obtained from a 17-year-old 4.59-kg castrated male domestic medium-hair cat with a history of second-degree atrioventricular (2° AV) block, showing an underlying sinus rhythm rate of 222 beats/min. A transient right bundle branch block pattern is evident, and there is a consistent PR interval, except following blocked P waves (solid arrow), such as after an initial wide QRS complex and then after subsequent successive wide QRS complexes (dashed arrows), consistent with Mobitz type II 2° AV block. The ECG diagnosis is sinus rhythm with Mobitz type II 2° AV block and transient rate-dependent right bundle branch block. Paper speed = 50 mm/s; 1 cm = 1 mV.

Discussion

Aberrant conduction is a ventricular conduction phenomenon defined as a transient block of the ventricular conduction system. This differs from a bundle branch block, which is an anatomic (fixed) block. Aberrant conduction occurs when an impulse reaches the conduction system before the interventricular conduction system has had time to completely repolarize.[1] The duration of a refractory period changes with cycle length; the refractory period is shortened when there is an increase in heart rate and is prolonged when there is a decrease in heart rate. There are 2 forms of aberrant conduction, namely tachycardia-dependent (phase 3 aberrancy) and bradycardia-dependent (phase 4 aberrancy) blocks.[2]

A form of phase 3 aberrancy, Ashman phenomenon, was first described by Gouaux et al[3] in association with atrial fibrillation. The generation of this aberrancy is dependent on the duration of the preceding cycle. A longer cycle preceding a shorter cycle can cause the right bundle branch to become refractory.[3] If the conduction of the next impulse after a shorter R-R interval occurs, the right bundle branch will become refractory.[3] The resulting aberrant conduction is termed Ashman phenomenon. For the cat of the present report, because the RBBB occurred when the cycle duration decreased and the heart rate accelerated, tachycardia-dependent RBBB with phase 3 aberrancy was initially considered; however, this would not explain the second aberrantly conducted QRS complex.

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The underlying mechanism of the transient but sustained nature of the tachycardia-induced aberrant conduction in the cat of the present report can be explained by the linking phenomenon. The linking phenomenon requires a macroreentrant circuit where there are 2 branches with different properties.[3–5] There is a dominant and a dependent pathway, which in this cat were the left bundle branch and right bundle branch, with preferential conduction through the dominant pathway and a dependent pathway that is characterized by a longer refractory period.[2] An impulse can travel down the dominant pathway but is blocked in the dependent pathway; however, it can retrogradely travel back up the dependent pathway, resulting in prolonging the right bundle branch refractory state.[2] The next antegrade impulse is not able to travel down the dependent pathway but conducts through the dominant branch and then reenters retrogradely.[4,5] This will occur alternately until a change in cycle duration occurs and allows for full recovery of the pathways, thus resulting in a transient and nonsustained aberrancy.[4]

For the cat of the present report, the other ECG abnormality was Mobitz type II 2° AV block. Second-degree AV block in cats has been associated with cardiac disease and systemic illness, such as hyperthyroidism.[6–8] Given that this cat had hypertrophic cardiomyopathy, that condition may have been an underlying contributing cause of the 2° AV block.

References

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