# ECG Quiz 21

CASSA
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A SPECIAL INTEREST GROUP OF SA HEART ASSOCIATION

ANSWER

Systematic analysis of the ECG shows:

1. Rate and regularity: Almost regular with a ventricular rate of 66 bpm.
2. Atrial activity: P-waves are seen preceding each QRS: these waves are positive in all the inferior leads and isoelectric in Lead I. The P-wave axis is 90°, whereas the normal sinus P-wave axis is from 15° to 75°. The axis suggests the rhythm is arising either from a high atrial ectopic focus or from the sinus node with atria that are slightly displaced byan enlarged, rotated heart. There appear to be additional P-waves associated with the end of the QRS complexes. This wave is not part of the QRS as there is a slight wobble between the wave and the QRS (best seen following 4th and 5th QRS in the V1 rhythm strip). Thus the atrial rate is 132 bpm. Interestingly, the atrial rate is not perfectly regular; and the P-wave which follows closely after the QRS does not occur midway between the P-waves associated with a long PR interval. The ventricular activity and atrial rhythm are not totally dis-sociated as in a complete AV block; rather, they are associated in a 2:1 pattern.
3. PR interval: Measures 9 small blocks x 0.04s = 360ms - almost double the normal upper limit of 200ms. Note that the PR intervals are constant and do not change.
4. QRS complexes: These are narrow with normal axis of around 60° and acceptable R-wave progression.
5. ST and T abnormalities: ST segment sag antero-laterally and biphasic T-waves in V4-6.

In summary: There is second degree heart block with the atrial rate double the ventricular rate. The atrial rate is fast: Possibly an atrial tachycardia but more likely a sinus tachycardia in a sick patient.

The question is what type of second degree AV block is it? Mobitz 1 (= Wenckebach), Mobitz 2 or another?

The generally used classification of second degree is dependent on observations from the ECG and not on the underlying pathophysiology, although there may be a link.

In Mobitz 1 we need to observe a progressive lengthening PR interval until a P-wave is not conducted as first described by Wenckebach from physical signs, not ECG observations. This patient's ECG is not Mobitz 1 because of 2 observations:

- No PR changes are noted; and, more importantly;
- No 2 consecutive P-waves are ever seen to conduct. Thus, the PR cannot be observed to be lengthening progressively in consecutively conducted beats. Only alternate P-waves conduct to the V, so it is impossible to describe this ECG as Mobitz 1 or Wenckebach second degree AV block.

In second degree AV block, Mobitz 2 must also be considered. As with Mobitz 1, this does not describe a mechanism but rather an observation. By definition, Mobitz 2 demands that the PR intervals of consecutively conducted P waves before and after a "dropped P-wave" remain constant and not lengthen or change as in Mobitz 1. Therefore, as alternate P-waves in this ECG are not conducted, it is impossible to call this Mobitz 2 second degree AV block.

As the classification of second degree AV block is simply dependent on observation and, in this case it is neither Mobitz 1 nor 2, we need to describe exactly what we see: 2:1 second degree AV block (Table 1). Thus, the correct answer is: (e).

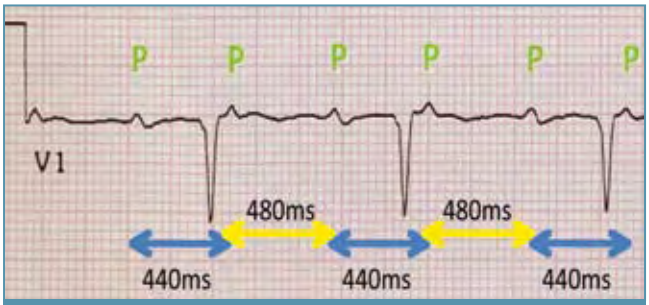


**FIGURE 1:** Second degree 2:1 AV conduction with ventriculophasic sinus dysrhythmia
Every second P-wave is conducted to the ventricles. The P-P intervals are not all the same, being shorter when a ventricular complex is present in between 2 P-waves (440ms) and longer when no ventricular complex occurs (480ms). This subtle alternation in P-P duration related to ventricular activity is called ventriculophasic sinus dysrhythmia.

| TABLE 1: Classification of 2° AV-block |
|---|
| Mobitz 1 (Wenckebach) |
| Mobitz 2 |
| Pattern with 2:1 or 3:1 etc. |

## FURTHER DISCUSSION

On examination it was noted that the patient had regular cannon waves visible in the jugular veins. These arise from atrial contraction against the closed AV (tricuspid) valve and confirm that the additional wave superimposed near the end of the QRS complex is indeed a P-wave coinciding with the ventricular contraction.

It was also mentioned above that the "P to P" intervals are not all equal. There are 2 different P-P lengths (Figure 1). The P-P interval with a QRS between the P-Ps is 40-60ms shorter than the P-P interval without a QRS: an interesting normal physiological phenomenon, called ventriculophasic sinus dysrhythmia, in which the ventricular beat advances the next P-wave and the absence of a QRS delays the next P-wave. The mechanisms thought to be involved include baroreceptors and the autonomic nervous system and also physical mechanical pulsation in the sinus node artery.

When 2:1 AV block is observed, it should be further evaluated to determine at which level of the AV conduction system the block has occurred: AV node, His bundle or more distally in the conduction and Purkinje system. This may help in the management and in suggesting the prognosis of the arrhythmia. Evaluation requires analysis of the QRS width, PR length of conducted beats, and response to exercise, manoeuvres or atropine (Table 2).

In this patient the QRS was narrow and the PR interval of the conducted beats was >300ms, all indicators of AV nodal disease (Table 3). In the absence of previous cardiac disease this new conduction problem was likely to be linked to his systemic illness. His illness, fever, collapsing pulse, auscultation of aortic regurgitation and sinus tachycardia on ECG suggested severe infective endocarditis. Echocardiography revealed an aortic root abscess burrowing into the septum and affecting the AV node, thus accounting for the ECG observations. Apart from valvular destruction caused by the infection, the concern was progression to complete third degree AV block and the risk of asystole.

## CONCLUSIONS/LESSONS

- Classification of the type of 2° AV block requires simple observation and categorising into one of 3 (not just 2) patterns: Mobitz 1, Mobitz 2 or the description of 2:1 or 3:1, etc.
- 2:1 or higher AV block needs further evaluation to localise the site of conduction block.

| TABLE 2: Evaluation of 2:1 AV-block |
|---|
| QRS configuration / width |
| PR interval of conducted beats |
| Response to Exercise |
| Response to Carotid Sinus Massage |
| Response to Atropine IV |

| TABLE 3: Determining Site of 2:1 AV-block | |
|---|---|
| QRS width | Wide QRS = site of block anywhere<br>Normal QRS = block in AV node or His bundle |
| PR of conducted P-wave | >300 milliseconds = block in AV node<br><160ms = block in HPS or His bundle |
| Atropine or exercise | Improved conduction = block in AV node<br>Worsened conduction = block in HPS or His bundle |
| Carotid Sinus massage | Improved conduction = block in AV node<br>Worsened conduction = block in HPS or His bundle |

*HPS: His Purkinje System.*
*Adapted from M Josephson. Clinical Cardiac Electrophysiology. 2008.*

**ECG** and **QUESTION** on page 280