QUIZ

The EKG Quiz: "Paradox!"

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History
You came across this EKG during routine EKG reading.

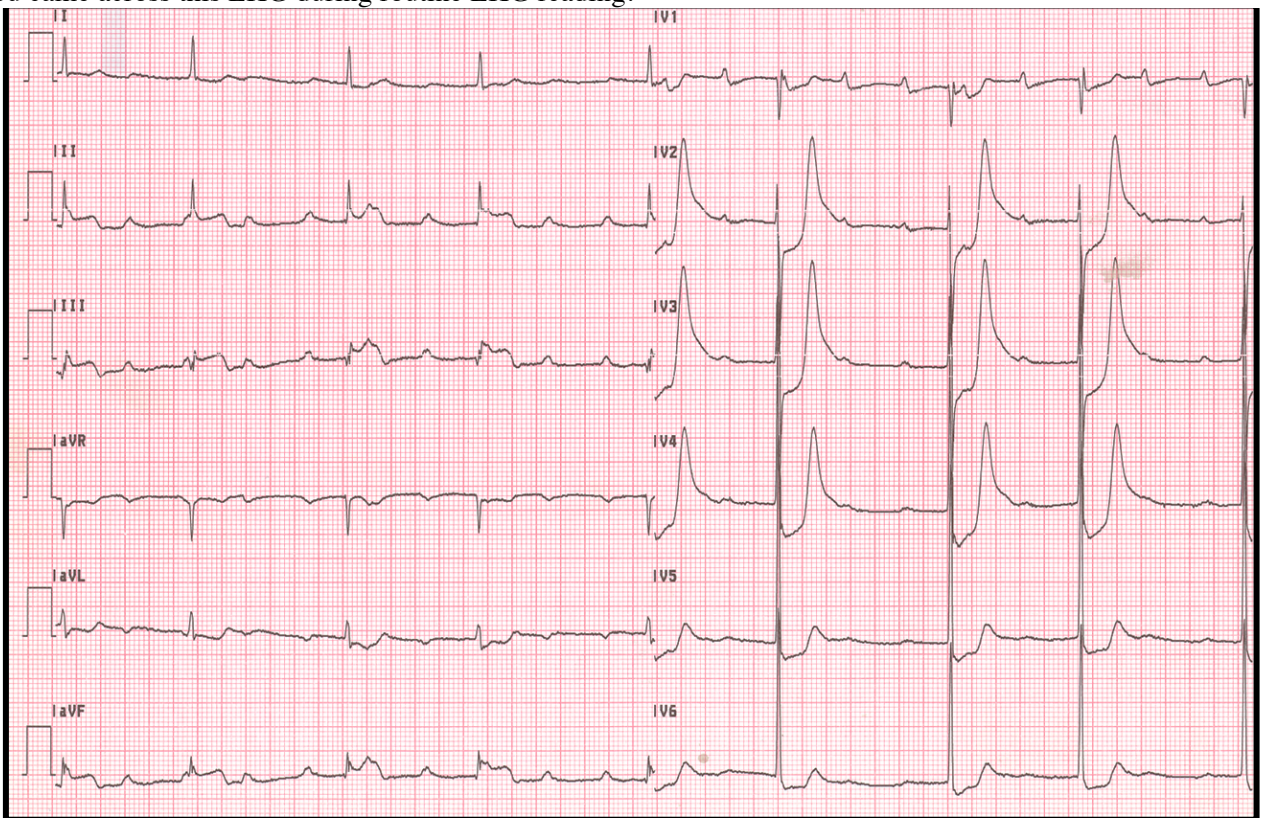

Figure 1. Abnormal EKG during routine reading.

Question 1. What are the main "rhythm" findings seen on this EKG?
A. Tachycardia B. Bradycardia C. Conduction abnormality
D. All of the above E. B and C only

Question 2. What is the likely underlying mechanism that explains the abnormalities seen on the EKG?
A. Complete heart block B. Ischemia C. Hyperkalemia
D. A and B E. All of the above

Please commit yourself for answers before you proceed further.

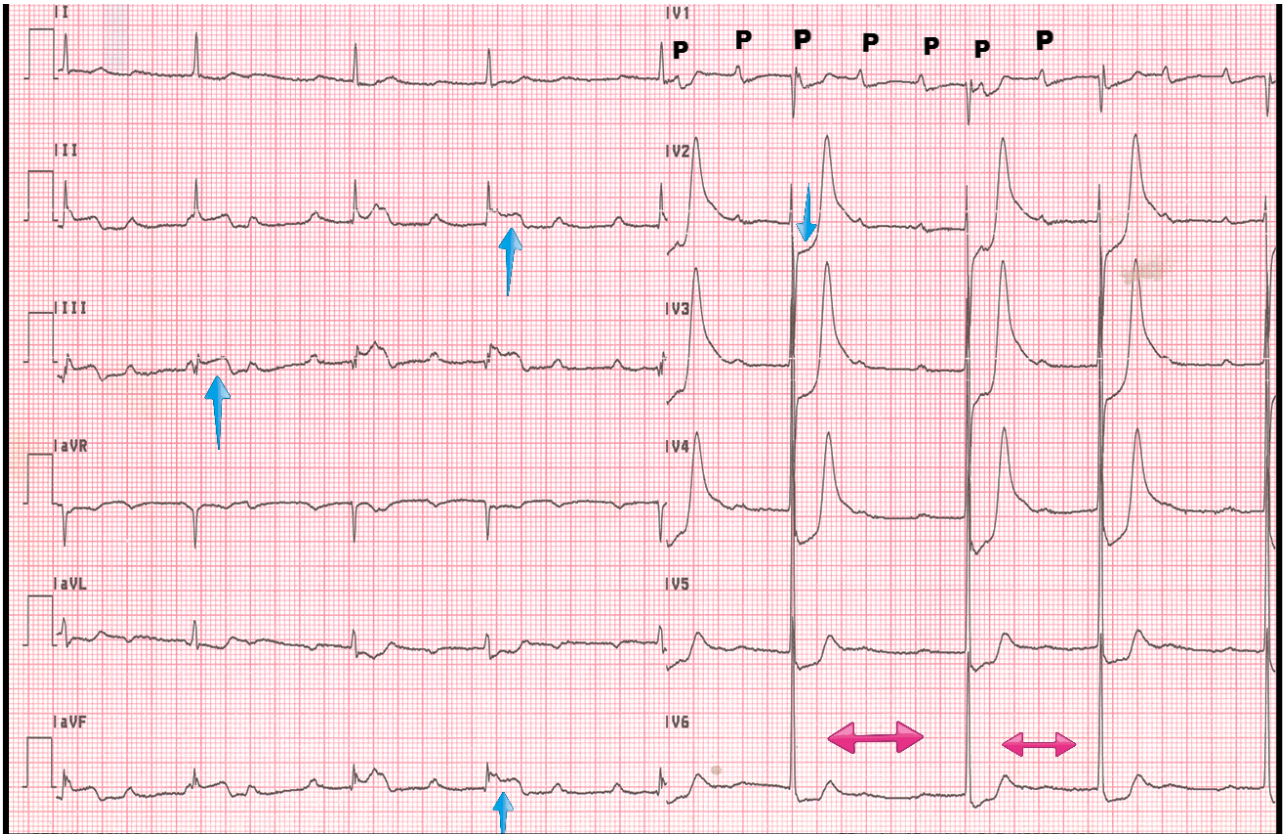

Figure 2. Findings are consistent with sinus tachycardia and high-grade AV block. There is also acute inferior-posterior myocardial infarction, which is the likely mechanism for the conduction abnormalities (see text for details).

Final answers

1. D (all of the above)
2. B (ischemia)

Discussion

This EKG shows multiple abnormalities. When there are multiple abnormalities, it is important to be systematic and describe the rhythm and physiological abnormalities first before you can conclude the likely underlying mechanism and pathology. Figure 2. illustrates these abnormalities:

Firstly, the ventricular rate is slow and irregular (in the 40s, i.e., ventricular bradycardia) with narrow QRS complexes. The irregularity is best precieved in the first three QRS complexes in lead V6 (double-headed red arrows). On the other hand; atrial activities are fast (best seen in lead V1). The atrial rate is about 120 beats per minutes, and the morphology of P waves suggests a sinus origin (upright in leads II, III, and aVF), so there is also a sinus tachycardia. Finally, not all P waves are conducted; hence conduction problem exists too. Therefore, this patient has bradycardia, tachycardia, and conduction abnormalities.

Secondly, a subtle, but definite, ST-segment elevation is seen in the inferior leads (II, III, and aVF) along with ST segment depression in leads V1-V4 (blue arrows) suggestive of acute infero-posterior myocardial infarction (MI). However, is there a "complete heart block" to explain the conduction abnormalities? According to this tracing, there is a high-grade atrioventricular (AV) block with multiple serial non-conducted P waves; nonetheless, there is no complete AV dissociation since there was no regular ventricular escape rhythm. In fact, some of these P waves are likely conducted; which explains the irregularities in the QRS complexes. Although a long rhythm strip would be most useful to delineate any conduction pattern, there is some “group-beating” and hence some of the beats with long PR interval are likely conducted with some Wenckebach's pattern (for example first and third beats in lead V6, and probably fourth beat in lead aVF). Since, there is no AV-dissociation; “complete heart block” is an inaccurate description.

Finally, there are tall and peaked T-waves in leads V2-V4. These may raise suspicion about hyperkalemia. The same leads have QRS complexes of high voltages (deep S waves) suggestive of possible underlying left ventricular hypertrophy. Therefore, these tall T-waves represent rapid repolarization of this thick ventricle.

In summary, there is evidence of acute infero-posterior myocardial infarction. There is also significant sinus tachycardia, with a high-grade AV block, but no complete AV dissociation. The T-wave abnormalities are likely secondary to hypertrophy and/or ischemia.

Variable degrees of AV block can be seen in inferior wall myocardial infarction. Also, sinus bradycardia, rather than tachycardia, is more often seen in this context. However, if another reason for enhanced sympathetic stimulation exists (e.g., pain, or hypotension, etc.), the patient may have sinus tachycardia instead, but because of the conduction abnormalities the ventricle rate remains slow which explains the “paradox” of fast atria and slow ventricles.

Most of these conduction abnormalities are transient and resolve after revascularization.

Take-home messages

1. For rhythm analysis, look at the atrium and ventricle separately.
2. For complete heart block, ventricular escape rhythm should be slow and "regular".
3. High-grade AV block, although bad, is not the same as complete heart block.
4. Not all peaked T- waves are secondary to hyperkalemia.
5. Don't forget to check for ST-segment elevation in inferior leads, which can be masked by the underlying conduction abnormalities.