ECG Puzzler

A regular feature of the American Journal of Critical Care, the ECG Puzzler addresses electrocardiogram (ECG) interpretation for clinical practice. To send an eLetter or to contribute to an online discussion about this article, visit www.ajcconline.org and click “Respond to This Article” on either the full-text or PDF view of the article. We welcome letters regarding this feature.

T-WAVE AMPLITUDE CHANGES

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Scenario: This electrocardiographic (ECG) rhythm strip was obtained from a 74-year-old man who arrived at the emergency department (ED) with expressive aphasia and right-sided weakness. Consistent with a transient ischemic attack (TIA), his symptoms lasted 30 minutes and had resolved just prior to hospital arrival. He had experienced similar episodes in the past month. A recent ultrasound estimated a 70% stenosis of the left internal carotid artery (LICA). A computed tomography angiogram upon ED arrival confirmed a 90% stenosis in the LICA and severe stenosis bilaterally in his vertebral arteries. He has a history of hyperlipidemia, type II diabetes, and coronary artery bypass surgery 3 years ago. During the recording of this cardiac rhythm, he was alert, oriented and vital signs remained within normal limits.

Interpretation Questions:

1. Is the ECG properly calibrated (10 mm) and are leads properly placed?  □ Yes □ No □ NA
   If no, interpret cautiously.

2. Is this a sinus rhythm (one P wave preceding every QRS complex)?  □ Yes □ No □ NA
   If no, check for number of P waves in relation to QRS complexes.

3. Is the heart rate (R-R interval) normal (60-100/min)?  □ Yes □ No □ NA
   If no, check for supraventricular or ventricular arrhythmias.

4. Is the QRS complex narrow (duration < 110 milliseconds [ms] in V1)?  □ Yes □ No □ NA
   If no, check for bundle branch blocks (BBBs), pacing, or ventricular arrhythmia.

5. Is the ST segment deviated (> 2 mm in V2-V3, or > 1 mm in other leads)?  □ Yes □ No □ NA
   If yes, check for similar deviations in contiguous cardiac territories.

6. Is the T wave inverted in relation to the QRS (> 0.5 mV)?  □ Yes □ No □ NA
   If yes, check for ST deviation or conduction abnormalities.

7. Is the QT interval lengthened (> 450 ms [women] or > 470 ms [men])?  □ Yes □ No □ NA
   If yes, check for ventricular arrhythmias or left ventricular hypertrophy.

8. Is R- or S-wave amplitude enlarged (S wave V1 + R wave V5 > 35 mm)?  □ Yes □ No □ NA
   If yes, check for axis deviation or other chamber hypertrophy criteria.

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Interpretation and Rationale

This is sinus bradycardia (10 second average heart rate equals 54/min) with frequent premature atrial contractions (PACs); 2 nonconducted PACs superimposed in the T-wave of beats 2 and 8 (arrows) and 1 conducted PAC (beat 5).

Nonconducted PACs occur when an ectopic atrial stimulus occurs so early that the AV node is refractory (unexcitable) from the previous impulse, therefore the impulse is not conducted to the ventricles. These are characterized by a premature P wave without an accompanying QRS complex, which is then followed by a pause. Nonconducted PACs can be easily confused with sinus arrest or sinus exit block because of their associated pause; therefore it is important to assess the preceding T wave to differentiate these rhythms.

Premature atrial contractions are caused by impulses that originate outside of the normal intrinsic pacemaker or sinoatrial node. These beats are characterized by abnormal appearing P waves (ie, size, shape, deflection [positive, negative, biphasic]), or may be hidden in the preceding T wave distorting its contour. The PR interval is typically normal but may be shortened slightly. The QRS complex is unchanged from the patient’s baseline because the ectopic impulse is generated above the atrioventricular (AV) node and therefore travels down the AV node and bundle branches normally.

PACs are usually asymptomatic and a benign finding in healthy individuals, but they can be associated with coronary or valvular heart disease, heart failure, respiratory failure, and digoxin toxicity. They can also be caused from extraneous stressors such as alcohol, caffeine, cigarette smoking, catecholamine release from pain or anxiety, and fever. PACs may be important in patients who have episodes of atrial fibrillation (AF) because frequent PACs (>100 per day) are associated with initiating AF.

Management

This patient arrived with a TIA and was recommended for an urgent carotid endarterectomy to prevent a stroke. In the ED, this rhythm was not associated with symptoms, therefore no immediate intervention was required. Treating PACs should be directed at the cause when symptomatic. However, continuous cardiac monitoring during his hospital stay might be indicated to determine if the PACs are transient, frequent, or if episodes of AF are seen. Since this patient has a history of heart disease, a postoperative cardiac work-up would be warranted.

Answers:

1. Yes, calibration is correct as noted by the calibration marks on the right side of the ECG.
2. Yes, there is a P wave preceding every QRS complex. Whereas it is difficult to appreciate the P wave for the fifth beat, it is superimposed within the T wave of the preceding beat, which suggests a conducted premature atrial contraction (PAC).
3. No, the heart rate is irregular and on average, fewer than 60/min.
4. Yes, the QRS complex is narrow.
5. No, the ST segment is not deviated in this lead.
6. No, the T wave is not inverted in this lead. The T waves for beats 2 and 8 (arrows) are taller than the other T waves suggesting there are PACs that are nonconducted.
7. No, the QT interval is not prolonged.
8. Left ventricular hypertrophy cannot be assessed from this one lead.
T-Wave Amplitude Changes
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