Challenges in Clinical Electrocardiography

An Unusual Wide Complex Rhythm—What Is the Diagnosis?

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A woman in her 80s was referred for a cardiac evaluation after results from an electrocardiogram (ECG) performed during a routine health evaluation showed a wide QRS complex. The patient had no previous medical records with her at the evaluation. An initial 12-lead ECG is shown in the **Figure**, A.

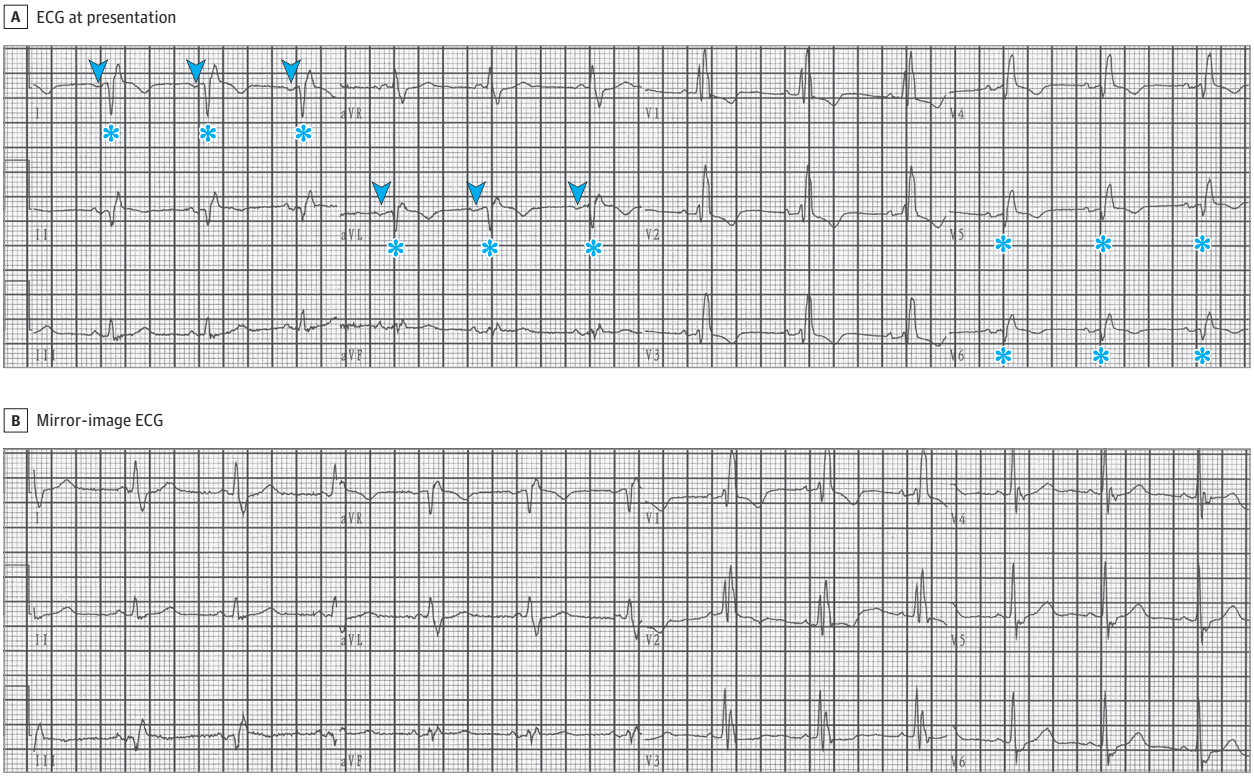
Questions: On close examination of the admission ECG, what are the unusual findings, and what is the most appropriate next step in the evaluation? How should the ECG be further analyzed?

Interpretation and Clinical Course

The initial ECG showed a wide complex rhythm at a rate of 76 beats per minute with right bundle branch block morphology and a QRS duration of 120 milliseconds (Figure, A). A closer examination showed negative P waves with pathological Q waves in leads I and aVL. There were positive P waves in lead V_1 and biphasic (initially positive followed by negative deflections) P waves in leads V_2 through V_6. There were pathological Q waves in leads V_5 and V_6. P wave morphology showed negative deflection in lead I, indicating that it is likely the result of conduction from the left atrium to the right atrium. The differential diagnosis included the right arm–left arm lead reversal, mirror-image dextrocardia, and left atrial rhythm.[1] If this was an example of a right arm–left arm lead reversal, lead I should be flipped. The pattern of lead aVR resembled a normal aVL, and lead II resembled a normal lead III. The precordial leads were unchanged. However, the ECG pattern did not identify the site of the bundle branch block. The inverted P waves in leads I and aVL with pathological Q waves and negative T waves could be misinterpreted as a left atrial rhythm with a previous high lateral myocardial infarction. However, the patient denied any history of chest pain. In addition, QRS complex morphology in chest leads is not consistent with conduction to the ventricles through the normal His-Purkinje atrioventricular conduction system. Therefore, there was 1 possible diagnosis left: mirror-image dextrocardia.

This patient was found to have the apex of the heart located at the right side of the chest accompanied by hepatic dullness that was located in the left subcostal region, supporting mirror-image dextrocardia. The mirror-image dextrocardia revealed mirror image on ECG. Therefore, the left arm lead was placed on the right arm, the

Figure. Electrocardiogram (ECG) Findings



A, Initial 12-lead ECG on presentation. The ECG shows right bundle branch block morphology. There are negative P waves with pathological Q waves in leads I and aVL, positive P waves in lead V_1, and biphasic (initially positive followed by negative deflections) P waves in leads V_2 through V_6. There were pathological Q waves in leads V_5 and V_6. The arrowheads arrows indicate negative P waves, and asterisks indicate pathological Q waves. B, Twelve-Lead ECG after correction according to mirror-image dextrocardia. The corrected ECG shows a normal sinus rhythm with complete right bundle branch block.

right arm lead on the left arm, V_1 lead in the left fourth interspace near the sternum, the V_2 lead in the right fourth interspace near the sternum, and V_3 to V_6 leads in the V_{3R} to V_{6R} positions.[2] The corrected ECG (Figure, B), which was obtained with the lead electrodes relocated to the respective mirror-image positions, demonstrated a normal sinus rhythm with complete right bundle branch block. The mirror-image dextrocardia was confirmed by obtaining a transthoracic echocardiogram, showing that the right atrium and right ventricle laid on the left side and the left atrium and left ventricle on the right side with its apex directed to the right.

Discussion

Mirror-image dextrocardia (mirror-image change) is most commonly seen in a right-lying heart.[2] It is primarily associated with situs inversus, in which all major visceral organs have a mirror-image orientation. Mirror-image dextrocardia is usually associated with some degree of abdominal situs inversus.[3] Close evaluation of the ECG changes may provide clues in diagnosing mirror-image dextrocardia. In patients with mirror-image dextrocardia, the anterior-posterior associations of the various parts of the heart are normal, but the right-to-left orientation is reversed. The ECG is characterized by a negative P wave in lead I and a progressive decrease in R-wave amplitude from leads V_1 to V_6, as in this case.[2,4] When mirror-image dextrocardia is not complicated with arrhythmia, ECG features are typical and easy to diagnose. If it is combined with other abnormal ECG changes (eg, intraventricular block, ventricular hypertrophy, and myocardial ischemia), electrocardiographic manifestations are diverse and atypical, and it is easy to cause misdiagnosis, as for this patient. Dextroversion that follows heart rotation into the right thorax with its normal chambers and adjacency relations is a consideration in the differential diagnosis of right-lying heart. The ECG is characterized as a positive P wave in lead I, and the QRS complexes in leads V_1 through V_6 reveal the activation of the ventricle in left thorax.[3,4] Mirror-image dextrocardia also differs from dextroposition, in which some extracardiac factors displace the heart into the right hemithorax. The ECG reveals a normal QRS complex in the precordial leads (V_1-V_6).[4,5]

Recognizing dextrocardia is an important and intellectually rewarding skill. Any ECG changes could be preliminarily analyzed in association with P, QRS, and T waves in lead I, as well as QRS complexes in leads V_1 through V_6. The clinical presentation and imaging examination can provide important information for diagnosis. Failure to recognize dextrocardia can lead to erroneous ECG interpretation. Once the ECG diagnosis of dextrocardia is made, other concerning ECG findings, such as the right bundle branch block in this patient, can be made.

Take-home Points

- The differential diagnosis of negative P wave in lead I includes the right arm–left arm lead reversal, mirror-image dextrocardia, and left atrial rhythm. Based on medical history, close evaluation of the ECG changes may provide clues in the differential diagnosis.
- When mirror-image dextrocardia is not complicated with arrhythmia, ECG features are typical and easy to diagnose. If combined with other abnormal ECG changes, electrocardiographic manifestations are diverse and atypical, and it may cause misdiagnosis.
- The clinical presentation and imaging examination can provide important information for diagnosis.
- Failure to recognize dextrocardia can lead to erroneous ECG interpretation. Once the ECG diagnosis of dextrocardia is made, other concerning ECG findings can be made.

ARTICLE INFORMATION

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