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Negative Concordance of T and U Waves: An Uncommon but Specific Electrocardiographic Sign of Cardiac Ischemia

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CASE REPORT

An 82-year-old man with dementia and type 2 diabetes mellitus presented to the emergency department with shortness of breath that had awakened him two hours earlier. He had not experienced any chest pain. He denied tobacco use and had no family history of premature coronary artery disease. His medication regimen included aspirin 81 mg taken orally each day. Vital signs at the time of presentation were blood pressure 136/71 mmHg, heart rate 82 beats per minute, respiratory rate 18 breaths per minute, and oxygen saturation 95% on room air and 100% on 2 L/min O2 via nasal cannula.

Physical examination was unremarkable except for trace pitting edema in the lower extremities. The results of laboratory testing which included a complete blood count, a basic metabolic panel, arterial blood gas values and b-type natriuretic peptide level were within normal limits and troponin I level was < 0.04 ng/mL (normal range, < 0.04 ng/mL). The 12-lead electrocardiogram (ECG) showed normal sinus rhythm, a QRS duration of 102 ms with a QRS morphology similar to that of a right bundle branch block, left axis deviation and inversion of T waves in leads V1 to V4. After the inverted T waves, a small negative deflection (an inverted U wave) was detected in leads V2 and V3. (Figure)

The patient was admitted to the intensive care unit and treated with morphine, oxygen, nitroglycerin, aspirin, metoprolol, atorvastatin and heparin. Serial ECG and troponin tests were performed every six hours. The second and third troponin tests showed that the patient's troponin I level increased first to 11.3 ng/mL and then to 18.5 ng/mL. The second ECG, which was obtained 12 hours after the first, showed much deeper T wave inversion (from 2 mm to 6 mm). A diagnosis of non-ST elevation myocardial infarction was confirmed by ECG findings and the levels of cardiac biomarkers.

DISCUSSION

A U wave is a deflection that occurs after the T wave on an ECG recording. A positive deflection is a known sign of hypokalemia. However, a negative U wave, which is defined as a negative deflection as small as 0.5 mV from the TP baseline, is a rare but very specific ECG finding that indicates myocardial ischemia. To identify a negative U wave, the possibility of a biphasic T wave or terminal T wave inversion should be ruled out by comparing the QT intervals in the leads that do not show negative U waves and those that do show this repolarization abnormality. It must
be remembered that a negative U wave is a transient ECG finding that may not be found in subsequent ECG examinations or revealed by a stress test. An inverted U wave, which may be the only ECG clue to cardiac ischemia, can also be associated with other ECG signs of cardiac ischemia, such as T wave inversion.

Reinig and colleagues studied the prognostic and predictive value of T and U wave inversion, analyzing three groups of patients in relation to their T and U wave findings. In the first group were patients with negative T wave and positive U wave (discordant type 1); in the second, patients with positive T wave and negative U wave (discordant type 2); in the third, patients with concordant negative T and U waves. They found that the patients with negative concordance of the T and U waves (ie, when both T and U waves are negative) had a significantly higher incidence of coronary artery disease (88%, \( P < .001 \)) and this is the most specific sign of cardiac ischemia. Perhaps more importantly, the inverted U wave has been linked with the occlusion of the left anterior descending coronary artery. That association suggests the importance and prognostic value of this ECG sign and explains the reason for which an inverted U wave is usually noted in leads V2 and V3.

Because an inverted U wave is also found in patients with hypertension, valvular disease or heart failure, it must be correlated with the patient’s clinical presentation. Thus U wave inversion is considered a specific sign of cardiac ischemia in patients who present with chest pain or an anginal equivalent symptom (eg, shortness of breath); those individuals must undergo an immediate and appropriate cardiac evaluation.

Our patient, who presented with negative T and U waves and an anginal equivalent symptom, was found to have a myocardial infarction with a significant subsequent elevation of his troponin I level. As in our patient, the negative U wave may present earlier than any significant elevation of cardiac biomarkers. This patient and his legal guardian decided not to pursue a more invasive workup with a cardiac catheterization because of the patient’s severe underlying dementia and other comorbid conditions. Although isolated T wave inversion can also be a sign of cardiac ischemia, this sign is not very specific.

In our opinion, the negative concordance of T and U waves is an important and specific ECG clue that is underdiagnosed, perhaps because of its small amplitude or a lack of awareness among physicians. Thus it is very important for healthcare providers in both inpatient and outpatient settings to be familiar with and look for this ECG sign in patients presenting with angina or anginal equivalents. The presence of a negative U wave, particularly if it is associated with a negative T wave, should lead to further workup for cardiac ischemia.

CONCLUSION

In patients with cardiac ischemia, an accurately interpreted ECG is one of the most effective guides to treatment and management. There are nine important ECG signs of cardiac ischemia. (Table) An inverted U wave is an uncommon but very specific sign of obstructive disease of the left anterior descending coronary artery. The association of an inverted T wave with an inverted U wave has even a higher specificity for cardiac ischemia and remains an underdiagnosed ECG sign.

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Table. Important ECG signs of cardiac ischemia

<table>
<thead>
<tr>
<th>ECG SIGN OF CARDIAC ISCHEMIA</th>
<th>CHARACTERISTIC FEATURES</th>
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<tbody>
<tr>
<td>Hyperacute T wave</td>
<td>It may or may not be associated with ST segment elevation. It is typically a broad and wide T wave with an amplitude of more than 75% of QRS.</td>
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<tr>
<td>ST segment elevation</td>
<td>It is usually convex, more than 1 mm, and in at least 2 adjacent leads localized to inferior, anterior, lateral or a combination of these regions of the hearts. It is a sign of transmural infarction.</td>
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<tr>
<td>New Left Bundle Branch Block (LBBB)</td>
<td>A new LBBB in a patient who presents with angina is considered equal to an ST elevation MI. Interpretation of ischemic ECG signs in the presence of LBBB (particularly ST elevation in precordial leads) is very difficult.</td>
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<tr>
<td>ST segment depression</td>
<td>It is usually more than 1 mm and in at least 2 anatomically adjacent leads.</td>
</tr>
<tr>
<td>T wave inversion</td>
<td>T wave inversion that is deep (usually equal or greater than 3 mm), symmetrical, new and localizes to an anatomical region of the heart, is suggestive of cardiac ischemia.</td>
</tr>
<tr>
<td>Pathologic Q waves</td>
<td>Abnormal Q waves are wider than 40 msec (&gt; 1 mm) and usually deeper than 2 mm. They are signs of old MI.</td>
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<tr>
<td>Poor R wave progression in precordial leads</td>
<td>Normally the R wave gradually becomes taller from V1 to V6. Absence of this gradual progression of R wave amplitude in the precordial leads can be a sign of anterior MI.</td>
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<tr>
<td>Tall R wave in V1 and V2</td>
<td>The presence of a tall R wave in lead V1 to V3 (especially V1) may be a sign of posterior MI.</td>
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<tr>
<td>Inverted U wave</td>
<td>Negative U waves are defined as a negative deflection as small as 0.5 mV from the TP baseline after T wave. Inverted U wave is a rare but specific sign of cardiac ischemia.</td>
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REFERENCES


