Challenges in Clinical Electrocardiography

# Shark Sighting in an Electrocardiogram

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## Case Presentation

An individual in their late 50s was transferred from an outside hospital to our higher-level of care because of an elevated high-sensitivity cardiac troponin (hs-cTn) level and abnormal findings on an electrocardiogram (ECG). The patient had presented earlier that day to the outside hospital with nausea, vomiting, and an altered mental status. Medical history was remarkable for poorly controlled diabetes type 2 (treated with insulin) and polysubstance use (cocaine, cannabis, tobacco); there was no history of cardiac disease. The patient was reported to be hypotensive, tachycardic, and tachypneic. Results of multiple metabolic tests were abnormal (potassium, 5.9 mEq/L; $HCO_3$, 3.8 mEq/L; glucose, 1472 mg/dL) and revealed acute kidney insufficiency (creatinine, 4.7 mg/dL; normal range, 0.4-1.3 mg/dL [to convert to µmol/L, multiply by 88.4]). The patient was treated for diabetic ketoacidosis and was intubated for airway protection. In addition, the patient's total creatinine kinase level was 15 958 U/L (normal range, 11-204 U/L) and initial hs-cTn level was 284 ng/L (positive, >52 ng/L). The result of toxicologic screening was positive for cannabis. The presenting ECG showed sinus tachycardia with prominent T waves that were initially attributed to the patient's metabolic derangement; however, several hours later, the hs-cTn level had risen markedly to 820 ng/L. The outside hospital repeated the ECG, and the results (**Figure**) prompted the transfer to higher-level care.

**Questions:** What is the most likely diagnosis? What other diagnoses should be considered?

## Interpretation

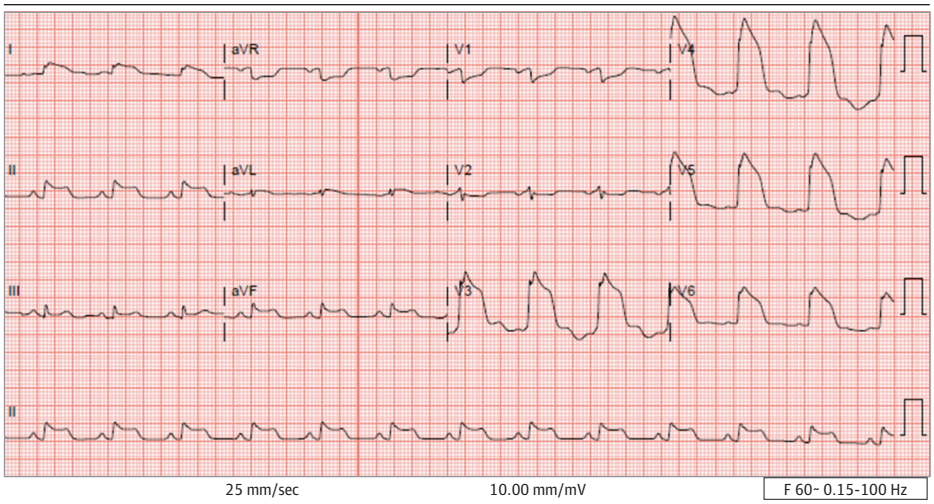
The ECG on transfer showed sinus rhythm with marked ST elevations in the inferolateral leads with a characteristic pattern entailing large R waves, loss of the ST segment, and massive ST elevation in the affected leads. There was also ST depression in leads aVR and $V_1$. Although the ST elevations were downsloping instead of the more typical concave upward or "tombstoning," this pattern has been associated most often with injury due to left anterior descending coronary occlusion.[1] Although rare (it is seen in just 1.4% of ST-elevation myocardial infarctions [STEMIs]), it is critically important to recognize this pattern that has been called the triangle,[1] lambda (λ),[2] or shark fin[3] pattern. Less often, it has been associated with stress (also known as Takotsubo) cardiomyopathy,[4] and rarely, with acute myocarditis.[5]

## Clinical Course

This patient also had significant ST depression in leads aVR and $V_1$ that overlie the base of the heart and may represent reciprocal apical injury. Together with the ST elevations, the site of abnormality or injury can be localized to the left ventricular apex inferolateral wall. An urgent cardiac catheterization was pursued owing to these ECG findings but no critical epicardial coronary lesions were identified. Results of an endomyocardial biopsy procedure and a right heart catheterization showed mildly elevated filling pressures and a reduced cardiac output. The patient also underwent an echocardiogram that demonstrated a left ventricular ejection fraction of 32% with mid anterior, mid inferoseptal, mid anteroseptal, and apical akinesis. The remainder of the left ventricle was hypokinetic. The absence of epicardial coronary disease and this pattern raised the possibility of stress cardiomyopathy in particular or myocarditis. The patient was treated for diabetic ketoacidosis, cardiogenic shock, and rhabdomyolysis, and experienced dramatic improvement. The myocardial biopsy specimen showed no evidence of inflammation or granulomata. The total creatinine kinase level peaked at 43 300 U/L and the hs-cTn level, at 8020 ng/L. The ST elevation resolved during 48 hours.

Eight days after the patient's initial presentation, a repeat echocardiogram and a cardiac magnetic resonance (CMR) study were per-

Figure. 12-Lead Electrocardiogram (ECG) With a Shark Fin Pattern




Findings of the ECG demonstrated the prominent R waves, ST elevation, and downsloping T waves characteristic of the shark fin pattern, also known as the triangle or lambda pattern.

formed and showed return of normal function, with the absence of wall motion abnormalities. The CMR study was of poor quality but the results suggested apical edema.

The exact cause of the patient's myocardial injury remained somewhat uncertain. The negative results of the endomyocardial biopsy specimen, the CMR showing edema, and the apical wall motion abnormality along with the rapid clinical recovery of the patient are consistent with a physically triggered stress cardiomyopathy. Although the patient's very high hs-cTn level may have suggested myocarditis, rhabdomyolysis probably contributed to it.[6]

## Discussion

The association of the shark fin pattern with STEMI, most notably, but also with stress cardiomyopathy and myocarditis, suggests that it may represent a more general response to myocardial injury. The exact mechanisms for this distinctive pattern are not known. However, several possibilities have been proposed, all likely resulting in a mismatch of endocardial or epicardial repolarization and creating a transmural voltage gradient, the characteristic large R wave, and downsloping ST segment—similar to the classic Brugada pattern also thought to be associated with such a gradient.[7] There are 3 mechanisms that have been postulated: (1) ischemic, at the epicardial or microvascular level that may be enhanced by localized edema, as seen with stress cardiomyopathy or the inflammation associated with myocarditis[8]; (2) mechanical, related to localized abnormal wall motion and left ventricular cavity expansion, as seen with aneurysms[9,10]; and (3) catecholaminergic, owing to increased metabolic demand or microvascular constriction.[9,10]

The shark fin ECG pattern associated with an elevated hs-cTn level mandates immediate coronary catheterization because acute epicardial coronary occlusion must be ruled out before other causes can be considered. The shark fin pattern has an increased risk of adverse events, including ventricular fibrillation (likely associated with dispersion of repolarization) and cardiogenic shock; therefore, it requires aggressive treatment.[1,4] In the absence of acute STEMI, consideration must be given to stress cardiomyopathy or myocarditis.

## Take-home Points

- The ECG triangle, lambda, or shark fin pattern should be considered an urgent indication for cardiac catheterization to rule out or treat acute STEMI.
- Commonly associated with acute STEMI, the shark fin pattern may also be seen in stress cardiomyopathy and myocarditis.
- With acute STEMI or stress cardiomyopathy, the shark fin ECG pattern is associated with adverse outcomes and an increased risk of ventricular fibrillation and cardiogenic shock.


### ARTICLE INFORMATION

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