

Inverted U wave & de Winter pattern: under-recognized sign of acute coronary occlusion

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Abstract

Background: Interpreting ECGs for evidence of ischemia in patients with noticeable changes, such as ST-segment elevation and ST-segment depression, can be easily identified. However, identifying & recognizing atypical ECG patterns of acute coronary syndrome is essential in preventing significant mortality and morbidity. In the following case report, we describe inverted U wave & de Winter pattern.

Case Illustration: A 58-year-old male presented to the emergency department with pressure-like chest pain. His initial evaluation revealed normal blood pressure and elevated blood glucose levels, and an initial ECG was incorrectly interpreted as normal. Eight hours later, he returned with worsened chest pain. The new ECG revealed the de Winter ECG pattern, which indicates acute occlusion of the left anterior descending artery. Additionally, previously overlooked inverted U waves in the initial ECG suggested myocardial ischemia. Eventually, the angiography revealed a complete occlusion of the proximal left anterior descending coronary artery. The patient underwent stent placement and have a good outcome.

Conclusions: Inverted U wave and the de Winter pattern described in this case indicates an acute LAD occlusion. It's a rare finding, but it is critical for emergency physicians to recognize it for urgent reperfusion therapy. Unfamiliarity with these high-risk ECG pattern may lead to delays in appropriate treatment, causing negative effects on morbidity and mortality.

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Introduction

Patients with suspected Acute Coronary Syndrome (ACS) present in a broad range of clinical scenarios and it is crucial to take a focused medical history and accurately characterize the presenting symptoms in order to manage the patient via the appropriate care pathway as soon as possible. The resting 12-lead Electrocardiogram (ECG) is the first-line diagnostic tool in the assessment of patients with suspected ACS. It is recommended that an ECG is obtained immediately upon first-medical contact and interpreted by a qualified emergency medical technician or physician within 10 minutes.¹⁻²

In the appropriate clinical context, ST-segment elevation (measured at the J-point) is considered suggestive of ongoing coronary artery acute occlusion in the following cases: New ST elevation at the J-point in at least two contiguous leads: (a) ≥ 2.5 mm in men <40 years, ≥ 2 mm in men ≥ 40 years, or ≥ 1.5 mm in women regardless of age in leads V2–V3, (b) and/or ≥ 1 mm in the other leads (in the absence of left ventricular hypertrophy or left bundle branch block).² Interpreting ECG for evidence of ischemia in patient with obvious changes, such as ST-segment elevation, can easily identified with criteria mentioned before. However, identifying & recognizing atypical ECG patterns of acute coro-

nary syndrome is essential in preventing significant mortality and morbidity.

In the following case report, we describe inverted U wave as an early sign of acute coronary occlusion, later developed into de Winter ECG pattern. These patterns are sign of acute coronary occlusion in the Left Anterior Descending coronary artery (LAD).

Case Illustration

A 58-year-old male presented to the emergency department with pressure-like chest pain on the right and left sides of the chest, radiating to the back, accompanied by sweating, which occurred especially during exercise and improved with rest. No radiation to the neck or left hand. The pain comes and goes in the last 4 days. No prior history of hypertension, diabetes, or family history of heart disease. The patient was an active smoker for the last 20 years. Blood pressure at 110/70 mmHg, heart rate at 74 BPM, no significant abnormality on physical examination, and no sign of congestion in both lungs. ECG was recorded and labelled as a normal sinus rhythm (Figure 1). Patient then treated for muscle-related chest pain with Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), an antispasmodic drug, and discharged.

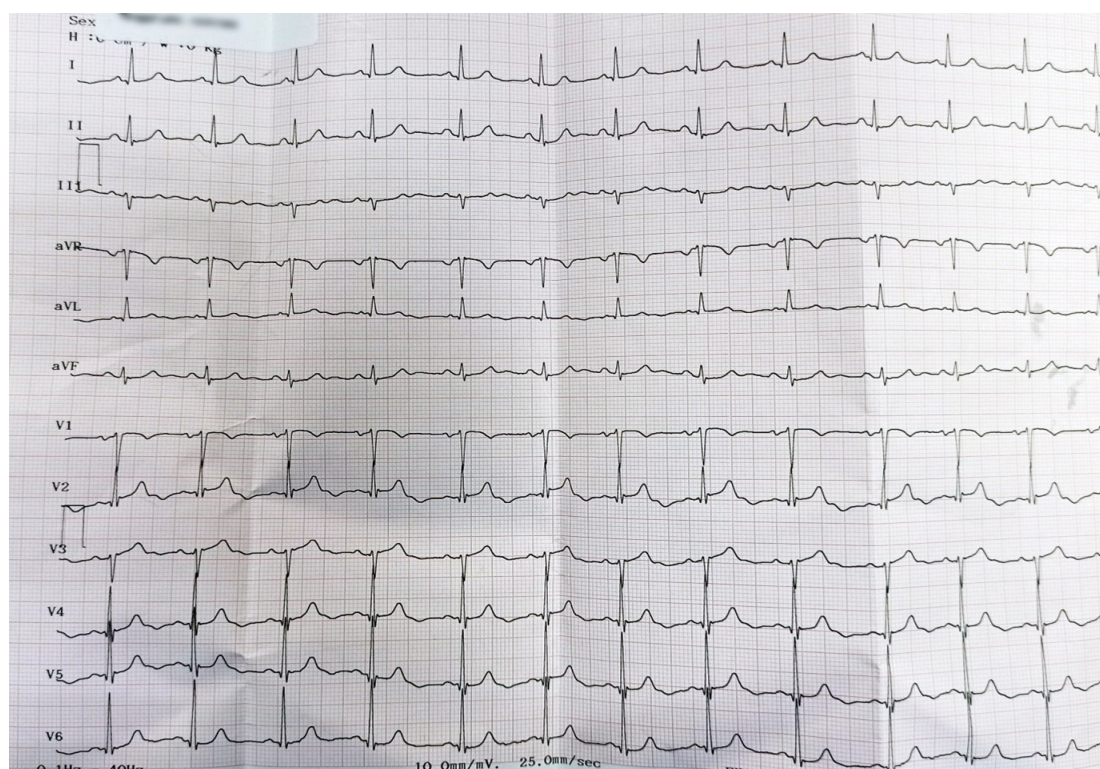


Figure 1. Electrocardiogram at the first emergency department visit.

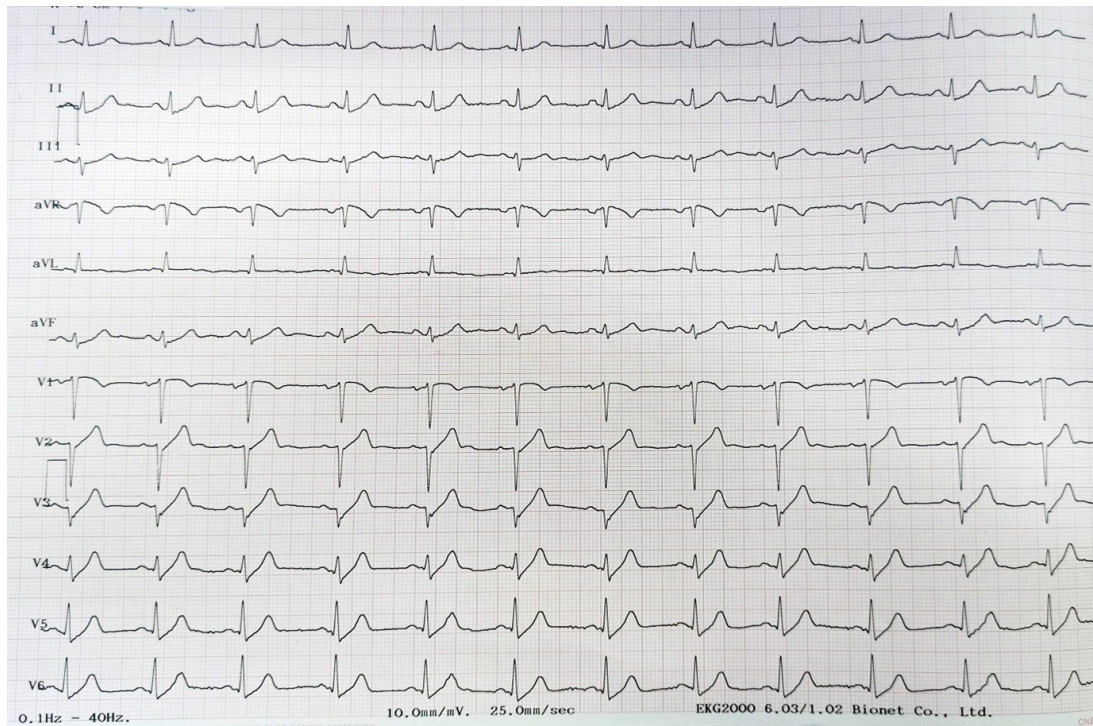


Figure 2. Electrocardiogram at the second emergency department visit, 8-hours after first visit.

Eight hours later, in the next shift, the patient came back with worsened chest pain accompanied by diaphoresis and shortness of breath. Blood pressure at 110/70 mmHg, heart rate at 76 BPM, oxygen saturation at 98% in room air. In the physical examination, we found fine crackles on both sides of the lungs, indicating pulmonary congestion. Recent ECG shows upsloping ST depression and peaked T waves in the precordial leads (V2-V5), which we recognized as the de Winter pattern, an anterior ST-Segment Elevation Myocardial Infarction (STEMI) equivalent (Figure 2). We performed a bedside echocardiography, which showed decreased contractility of the left ventricle, particularly in the basal-mid anteroseptal region, possibly due to myocardial stunning. The patient now receives proper therapy for ACS, including aspirin, clopidogrel, and nitrates. We also give furosemide to relieve the congestion. Laboratory results show random glucose at 232 mg/dl (hyperglycaemia suggesting diabetes) and elevated cardiac troponin-I at 8.12 ng/mL. Patient was immediately transferred to a higher-care hospital with a Percutaneous Coronary Intervention (PCI) capability.

During PCI, we found a total occlusion in the proximal LAD, a 70% stenosis in the proximal Left Circumflex coronary artery (LCX), and a 30% distal stenosis in the Right Coronary Artery (RCA). A stent was inserted into the LAD after successful

balloon dilatation. Follow-up angiography demonstrates TIMI grade III flow. The Patient then transferred to the Intensive Cardiovascular Care Unit for further observation. After 2 days of observation, echocardiography was performed and shows normal valvular and chamber with normokinetic left ventricle (LVEF 82%), with diastolic dysfunction (E/A: 0.8). Patient then discharged in an excellent condition and gets oral therapy including Ticagrelor 2x90mg, Acetylsalicylate Acid 1x80mg, Atorvastatin 1x20mg, Bisoprolol 1x2,5mg, Isosorbide Dinitrate 3x5mg, Candesartan 8mg 1x1, and Metformin 3x500mg.

Discussion

Despite the obvious clinical presentation of acute coronary syndrome, the first emergency physician discharged the patient because there are no typical ECG findings and the ECG didn't meet the STEMI criteria. Currently, there are still many emergency physicians who are only focused on the clinical presentation of acute coronary syndrome with ST elevation or depression ECG changes, so that early changes in the ECG that represent other acute coronary syndromes may be missed. The ECG at the first encounter only showed negative or inverted U waves in the precordial leads (Figure 3) and had been missed as an early sign of acute coronary occlusion. Failure to recognize this ECG

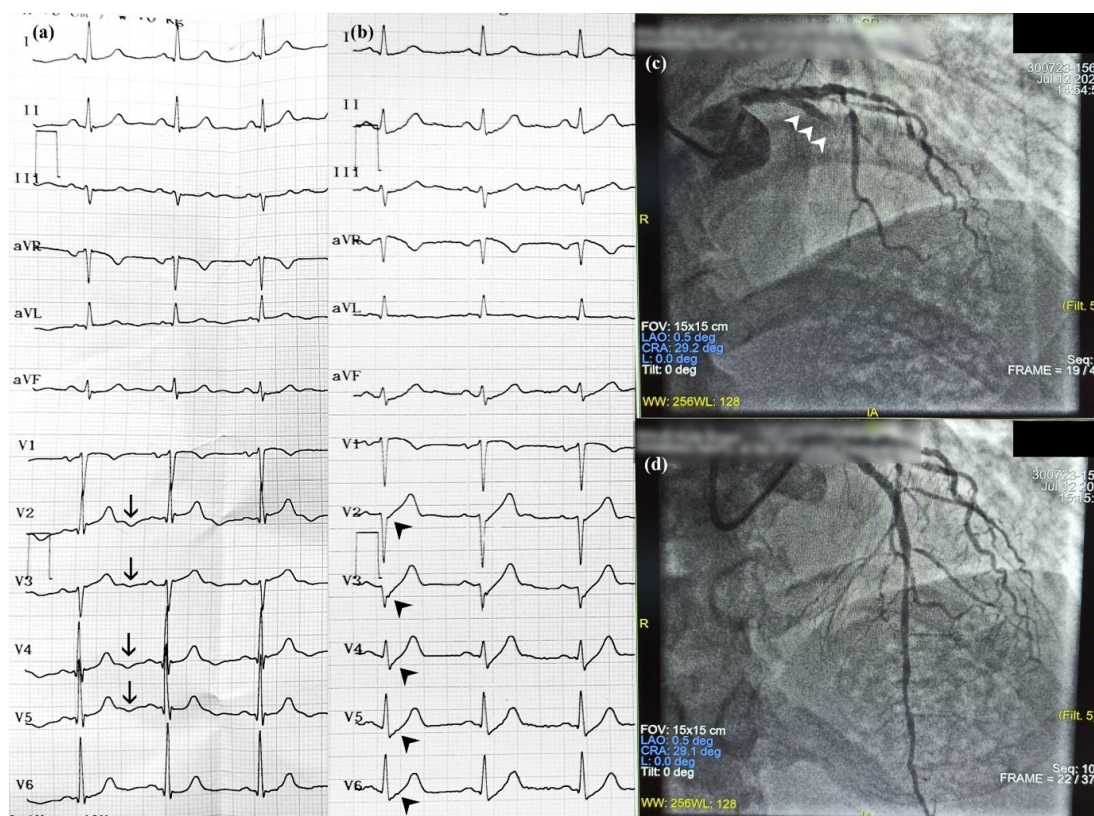


Figure 3. Comparison between initial ECG and serial ECG 8-hours later. (a) Inverted U waves in precordial lead marked by black arrow. (b) Upsloping ST depression in precordial lead marked by black arrowhead. (c) Total occlusion of proximal LAD marked by white arrowhead. (d) After PCI in LAD, TIMI grade III flow.

pattern led to the patient's discharge without a diagnosis of acute coronary syndrome, resulting in a lack of aggressive treatment from the outset. Inversion of the U-wave with an upright T-wave has pathological significance. An inverted U wave appears in various pathological conditions, including myocardial ischemia, coronary vasospasm, valvular disease, hypertension and cardiomyopathy.³⁻⁴ In a patient with acute chest pain, a negative U-wave in the precordial leads represents a significant LAD lesion until proven otherwise.⁵

Interestingly, patients with an anterior wall myocardial infarction and negative U waves in the precordial leads have smaller infarcts, less ST-elevation, better collateral circulation, and a larger amount of stunned but viable myocardium.⁵ The stunned myocardial we've seen in first bed-side echocardiography represent this statement. Decrease left ventricular contractility because of stunned myocardium responsible for the pulmonary congestion we found in second encounter with the patient. After reperfusion therapy, echocardiography shows improvement

in contractility with no regional wall motion abnormality and preserved ejection fraction.

The de Winter ECG pattern first described in 2008 as new typical ECG pattern in patients with ischemic chest pain and a large acute transmural anterior myocardial infarction.⁶⁻⁷ It has been linked with significant occlusion of the proximal LAD and in some cases total occlusion, as in our case.⁸⁻¹² Instead of the signature ST-segment elevation, the ST segment showed a 1- to 3-mm upsloping ST-segment depression at the J point in leads V1 to V6 that continued into tall, positive symmetrical T waves. The QRS complexes were usually not widened or were only slightly widened, and in some there was a loss of precordial R-wave progression. In most patients there was a 1- to 2-mm ST-elevation in lead aVR.⁶⁻⁷ This pattern seen in 2% of acute LAD occlusions. Additionally, de Winter pattern is often considered to be an 'STEMI equivalent'.¹³ Therefore, these patients qualify for immediate reperfusion therapy.⁶⁻⁷ It

is of great importance that all physicians and paramedics involved in triage of patients with chest pain do recognize this ECG pattern, and immediately refer these patients for immediate reperfusion therapy.⁶

The presentation of these two rare and often under-recognized ECG patterns in a single patient is truly unique. The presence of the inverted U wave, alongside the de Winter ECG pattern, serves as a significant indicator of an acute proximal occlusion of the LAD artery. These findings align with established medical literature, as angiography revealed a total occlusion in the proximal segment of the LAD artery in this patient.

Unfortunately, in the first encounter patient has been prematurely discharged and not getting the proper treatment. In suspected ACS, acquire and interpret ECG within 10 minutes to guide management. If the initial ECG is nondiagnostic, perform serial 12-lead ECGs, especially if suspicion remains high or symptoms persist. Current guidelines recommend serial troponin testing using the 0 h/1 h (preferred) or 0 h/2 h algorithms. Measure high-sensitivity cardiac troponin (hs-cTn) at 0 h and 1 h/2 h; a very low initial hs-cTn or no increase indicates rule-out pathway, while high levels or an increase suggest rule-in pathway. If hs-cTn is unavailable, repeat conventional cardiac troponin (cTn) assays after 3 to 6 hours. Patients who don't fit these criteria should be observed, with a third measurement at 3 h. Echocardiography and CT angiography can help identify patients with non-obstructive coronary arteries.^{2,14-15} However, many hospitals in Indonesia face financial limitations that restrict their ability to implement these strategies. The most practical approach available is to conduct a serial ECG at 30 to 90-minute intervals or, if available, to use a conventional serial cTn assay.

In the end, our findings on this case adds new evidence to the literature showing that in the clinical context of chest pain, if we found negative U wave in the precordial leads, it represents a significant LAD lesion until proven otherwise. This later can develop into more atypical pattern of acute coronary occlusion

such as de Winter ECG pattern. These two kinds of ECG didn't meet the typical STEMI criteria but still a sign of acute coronary occlusion and should not be missed.

Conclusion

In summary, an inverted U wave and the de Winter pattern described in this case indicates an acute LAD occlusion. It's a rare and atypical finding, but it is critical for emergency physicians to recognize it for urgent reperfusion therapy. Unfamiliarity with these high-risk ECG pattern may lead to delays in appropriate treatment, causing negative effects on morbidity and mortality.

List of Abbreviations

| | |
|--------|--|
| ACS | Acute Coronary Syndrome |
| cTn | Cardiac Troponin |
| ECG | Electrocardiogram |
| hs-cTn | High-Sensitivity Cardiac Troponin |
| LAD | Left Anterior Descending Artery |
| LCX | Left Circumflex Coronary Artery |
| LVEF | Left Ventricular Ejection Fraction |
| NSAID | Non-Steroidal Anti-Inflammatory |
| PCI | Percutaneous Coronary Intervention |
| RCA | Right Coronary Artery |
| STEMI | ST-Segment Elevation Myocardial Infarction |
| TIMI | Thrombolysis In Myocardial Infarction |

Ethical Clearance

Formal ethical approval from Ethics Committee RSUD Kota Bogor.

Publication Approval

The corresponding author confirms that all listed authors have read and approved the final manuscript for submission and affirm that the work is original and has not been simultaneously submitted or previously published elsewhere.

Authors Contributions

Z.F.M. was primarily responsible for collecting the patient data, performing the literature review, and drafting the initial manuscript. R.M. was provided the clinical care for the patient, contributed to the conception and design of the case presentation and critically revised the manuscript. All authors

meet the ICMJE criteria for authorship and take responsibility for the integrity of the content.

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None.

Conflict of Interest

All authors declare no competing interests (financial, personal, or professional) relevant to the subject matter or materials discussed in this case report.

Availability of Data and Materials

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Generative AI and AI-Assisted Technologies in the Writing Process

Authors acknowledge that artificial intelligence (AI) tools were only used to assist in language editing and did not generate or alter the scientific content, analyses, or conclusions presented in this manuscript.

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