Clinical Case Report

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Lambda-like ST-segment elevation in acute myocardial infarction triggered by coronary spasm may be a new risk predictor for lethal ventricular arrhythmia

A case report

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Abstract

Rationale: The lambda-like ST-elevation electrocardiography (ECG) pattern is extremely rare in patients with type 2 myocardial infarction (T2MI) triggered by coronary spasm. When this ECG pattern appears, sudden cardiac death (SCD) caused by lethal ventricular arrhythmia may occur because clinicians do not pay sufficient attention to this phenomenon.

Patient concerns: We describe a 41-year-old man who presented with steep down-sloping ST-segment elevation, paroxysmal ventricular tachycardia, severe sinus bradycardia, and intermittent complete atrioventricular block on ECG during the sudden recurrence of clinical symptoms.

Diagnosis: T2MI complicated with lethal arrhythmia and caused by coronary spasm.

Interventions: The patient received an implantable cardioverter defibrillator (ICD) for SCD caused by lethal ventricular arrhythmia and received long-term calcium-blocker and nitroglycerin therapy.

Outcomes: At a 3-month follow-up, no recurrence was noted.

Lessons: The lambda-like ST-elevation pattern is identified with other ST-elevation patterns by geometry and may be a new risk predictor for lethal ventricular arrhythmia on ECG. When this pattern is identified, clinicians should adopt aggressive therapeutic strategies, including ICD implantation and etiological treatment.

Abbreviations: CAD = coronary artery disease, CnI = cardiac troponin I, ECG = electrocardiography, ICD = implantable cardioverter defibrillator, LAD = left anterior descending, LCX = left circumflex artery, MI = myocardial infarction, RCA = right coronary artery, SCD = sudden cardiac death, T2MI = type 2 myocardial infarction, VF = ventricular fibrillation, VT = ventricular tachycardia.

Keywords: coronary spasm, implantable cardioverter defibrillator, lambda-like ST-elevation pattern, lethal ventricular arrhythmia, type 2 myocardial infarction

1. Introduction

Sudden cardiac death (SCD) currently accounts for a considerable proportion of all cardiac deaths. The most common cause of SCD is coronary artery disease (CAD), especially acute myocardial infarction (AMI). In 2012, a redefinition of myocardial infarction (MI) with as many as 5 different types was introduced for the first time.[1] Among these types, type 2 myocardial infarction (T2MI) is secondary to an imbalance between myocardial oxygen supply and demand associated with conditions other than coronary atherosclerosis.[2–4] In addition, coronary spasm is a rare cause of T2MI, and severe coronary spasm can trigger malignant arrhythmias, including ventricular tachycardia (VT), ventricular fibrillation (VF), severe sinus bradycardia, and complete atrioventricular block. However, data regarding the shape of ST segment elevation in T2MI triggered by coronary spasm and the risk of lethal arrhythmias or SCD are limited.

One of the ST segment abnormalities is a lambda-like ST-elevation pattern, which was first described by Riera et al[5] and was further characterized by Gussak et al.[6] On electrocardiography (ECG), the QRS complex, with its both slurry up-sloping and steep down-sloping limbs, resembles the Greek letter lambda.[6] Sato et al[7] and Aizawa et al[8] affirmed that the characteristic lambda-like ST-elevation pattern was associated with VF during myocardial ischemia.[7,8] This rare ECG pattern may be a new risk marker for fatal ventricular arrhythmia in patients with AMI. However, Riera et al[5]

Editor: N/A.

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The authors have no funding and conflicts of interest to disclose.

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Medicine (2018) 97:49(e13561)

Received: 8 August 2018 / Accepted: 14 November 2018

http://dx.doi.org/10.1097/MD.0000000000013561

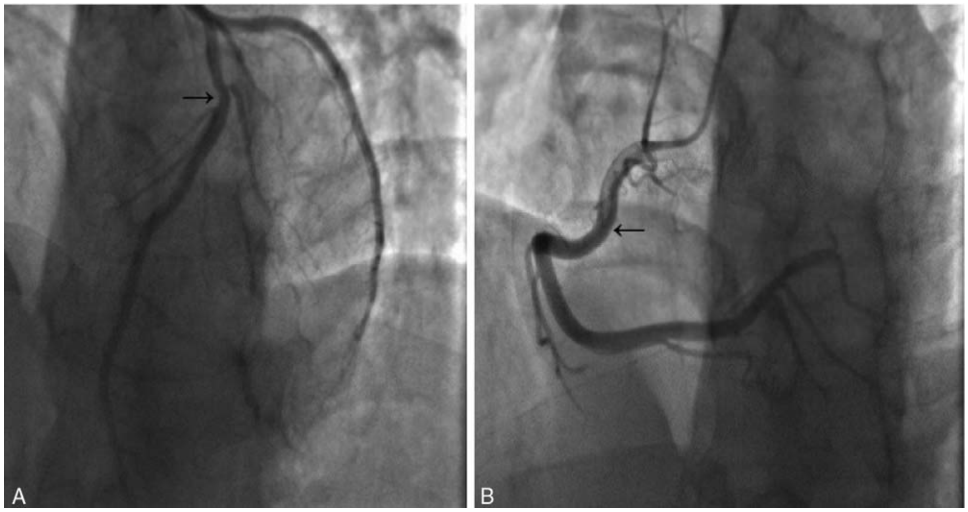

Figure 1. (A) Coronary angiography shows 30% stenosis in the proximal left anterior descending (LAD) coronary artery and no stenosis in the left circumflex artery (LCX). (B) Coronary angiography shows no stenosis in the right coronary artery (RCA). LAD = left anterior descending, LCX = left circumflex artery, RCA = right coronary artery.

described a patient without any clinical or other signs indicative of AMI and identified an extremely short interval coupling of the first premature ventricular complexes that prompted the R-on-T phenomenon, triggering VF and degenerating into fatal asystole.

Here, we present a patient with T2MI triggered by severe coronary spasm and lambda-like ST-segment elevation, which was complicated with life-threatening arrhythmia. The patient received an implantable cardioverter defibrillator (ICD) to prevent SCD caused by lethal ventricular arrhythmia. Our description of this rare case will alert physicians to the importance of lambda-like ST-segment elevation in patients with AMI and channelopathy, thereby allowing early aggressive therapeutic strategies.

2. Case report

A 41-year-old man presenting with chest tightness and chest pain accompanied with syncope was admitted to our emergency department. His symptoms lasted intermittently for 6 hours. He was a nonsmoker, and he did not have any of the classical risk factors for CAD. Four months previously, he visited our hospital because of persistent chest tightness and chest pain. Admission ECG showed T waves with deep inversion in anterior wall leads, and the admission hypersensitivity cardiac troponin I (CnI) level was 3859 pg/mL. After admission, echocardiography showed abnormal segmental motion of the left ventricle, and coronary angiography revealed 30% stenosis in the proximal left anterior descending (LAD) coronary artery and no stenosis in the left circumflex artery (LCX) and right coronary artery (RCA) (Fig. 1). During hospitalization, the above-mentioned symptoms occasionally occurred in the morning, and he was eventually diagnosed with T2MI. After discharge, he responded well to calcium blockers and long-term nitroglycerin therapy and did not show symptoms. However, his symptoms reappeared with syncope at 4 AM on March 28, 2018. On physical examination, he appeared unconscious. The readmission hypersensitivity CnI level was 1931.14 pg/mL, and blood gas analysis showed a pH of 7.315, PO_2 of 81.9 mm Hg, PCO_2 of 40.8 mm Hg, and Lactic level of 3.7 mmol/L. His ECG changes were consistent with the sudden recurrence of the above-mentioned symptoms, including chest tightness, chest pain, and syncope. Holter monitoring recorded the paroxysmal process for 30 minutes, and it revealed sinus rhythm, paroxysmal ventricular tachycardia, severe sinus bradycardia, intermittent complete atrioventricular block, and a steep down-sloping ST-segment elevation in I, II, III, aVF, and V_3-V_6 leads, resembling the Greek letter lambda, accompanied by an up-sloping ST-segment depression in the aVR lead (Fig. 2). After readmission, he received an ICD, and his symptoms did not reappear after the implantation. He continued the previous drug therapy after discharge, and he has remained symptom-free during a 3-month follow-up.

This case report was performed according to the guidelines of the Medical Ethics Committee of the Affiliated Yantai Yuhuangding Hospital of Qingdao University, in compliance with the Helsinki Declaration of 1964 and its later versions. The patient provided informed consent for the publication of this case report.

3. Discussion

The rare lambda-like ST-elevation pattern caused by severe coronary spasm, especially multiple coronary spasms, is noteworthy. We consider the lambda QRS-ST-T waveform as a new visual risk predictor for fatal ventricular arrhythmia. The pattern is defined as the presence of an elevated J wave (amplitude ≥1/4 R wave and ≤R wave) followed by a steep down-sloping elevated ST segment that merges with the inverted T wave, forming a lambda shape (Fig. 3). We confirmed the differences between the lambda waveform and other ST segment elevation waveforms with a novel approach. According to geometry, the range of the included angle between the isoelectric line and tangent line (connecting the J point and the convex point of the J-ST-T complex) is 0° to −90° (Fig. 4A). Additionally, the tangent value of the above angle is negative. Cipriani et al[9] suggested that the triangular QRS-ST-T pattern predicted cardiogenic

Figure 2. (A) Paroxysmal electrocardiography (ECG) shows a steep down-sloping ST-segment elevation, resembling the Greek letter lambda in the II lead. (B) ECG shows paroxysmal ventricular tachycardia. (C) ECG shows complete atrioventricular block. ECG = electrocardiography.

shock associated with high in-hospital mortality. We found that the triangular waveform is an extreme form of the lambda waveform, which also lies in the included angle range (Fig. 4B and C). In contrast, the range of angles with straight and up-sloping ST-elevation patterns is 0° to 90°, and the tangent values are positive (Fig. 4D).

Compared with other ST-elevation patterns, the lambda-like ST-elevation pattern is closely related to early abnormal ventricular repolarization, which involves acute myocardial ischemia and genetic abnormality.[10,11] During acute myocardial ischemia, changes in potassium (K^+), sodium (Na^+), and calcium (Ca^{2+}) channels lead to augmentation of the transient outward current (I_{to}), creating transmural or spatial heterogeneity of voltage gradients, which can produce phase 2 reentry-related R-on-T extrasystole and subsequent VF, and causing the lambda-waveform pattern on ECG.[7,12] Sato et al. suggested that the pattern may be a warning sign for the development of VF in myocardial ischemia as well as in atypical Brugada syndrome.[7] In addition, genetic mutations affect cardiac Na^+, K^+, and Ca^{2+} channels, leading to abnormal currents and predisposing the patient to life-threatening ventricular arrhythmias, which are referred to as channelopathies.[11] Riera et al[5] described a patient without AMI who had SCD because of genetic mutations, which caused the initiation of VF. Hosseini et al[13] evaluated the clinical validity of 21 genes and classified only 1 gene (*SCN5A*), which encodes for the cardiac Na^+ channel, as having definitive evidence. Na^+ channel mutation has been shown to be associated with ischemia-induced arrhythmic storm.[14] Thus, the unique ST-elevation pattern may be different from that observed in AMI patients without genetic mutations.[11]

The lambda-like ST-elevation pattern may be a new risk predictor for lethal ventricular arrhythmia in patients with AMI triggered by coronary spasm. The management of lethal

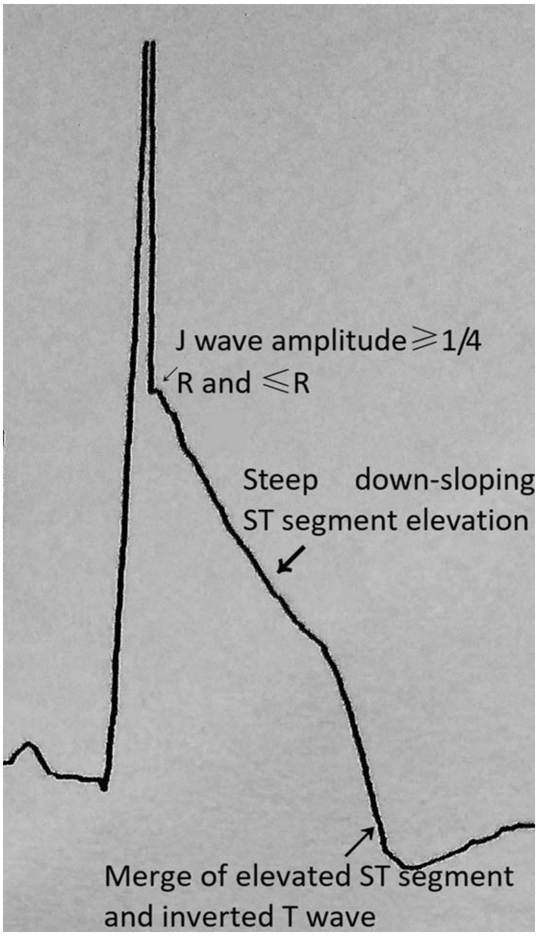

Figure 3. Schematic representation of the lambda-like ST-elevation waveform.

ventricular arrhythmia involves a class I indication for ICD implantation.[10] ICD implantation is the only effective approach to prevent SCD caused by VT/VF.

4. Conclusion

In summary, we reported a rare case of lambda-like ST-segment elevation in T2MI triggered by coronary spasm, and there were 4 important observations. First, the lambda-like ST-elevation waveform may be a new ECG risk predictor for lethal ventricular arrhythmia in patients with AMI triggered by coronary spasm. Second, geometry may be used to differentiate the lambda-like ST-elevation pattern from other ST-elevation patterns on ECG. Third, the pathogenesis of the lambda-like ST-elevation waveform may include acute myocardial ischemia and genetic mutation. Finally, when this pattern is identified, clinicians should adopt aggressive therapeutic strategies, including ICD implantation and etiological treatment. However, randomized controlled trials are required to confirm our observations.

Author contributions

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Visualization: Guangqiang Wang, Chuanhuan Zhang.
Writing – original draft: Guangqiang Wang, Na Zhao.
Writing – review & editing: Guangqiang Wang, Na Zhao, Chuanhuan Zhang, Xuexun Li.

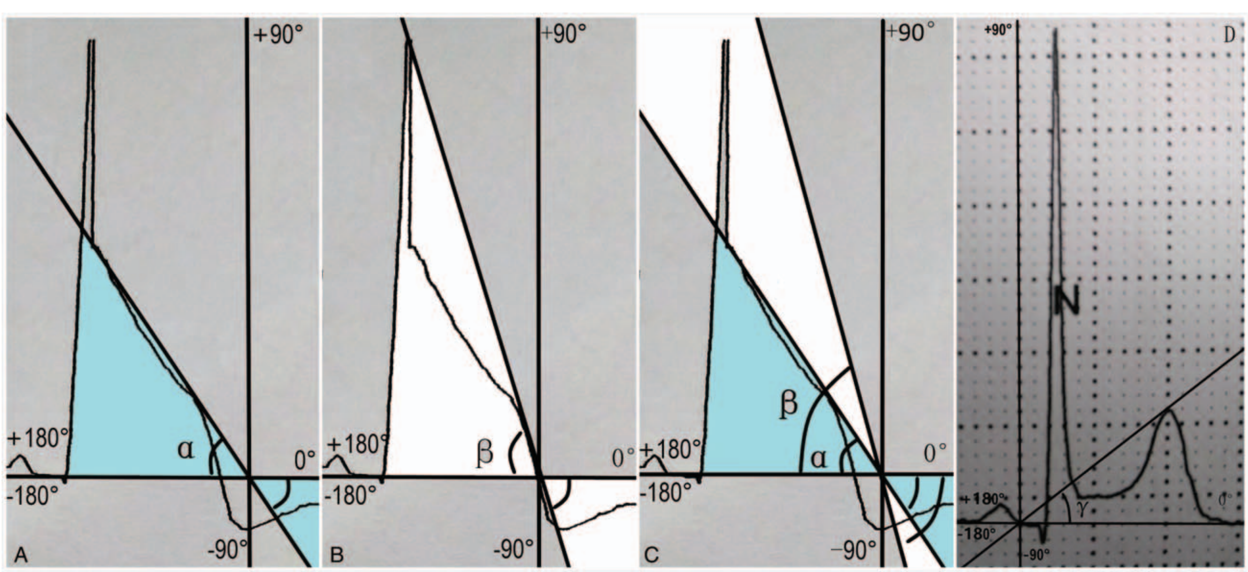

Figure 4. Comparison of the lambda-like ST-elevation pattern and other ST-elevation patterns by geometry. (A) α represents the included angle with the lambda-like ST-elevation pattern, and the angle range is from 0° to −90°. (B) β represents the included angle with the triangular waveform pattern, indicating the extreme form of the lambda waveform pattern, and the angle range is from 0° to −90°. (C) Comparisons of the values of α and β showing 0° < α < β < −90°. (D) γ represents the included angle with the straight ST-elevation pattern, and the angle range is from 0° to 90°.

References

[1] Thygesen K, Alpert JS, Jaffe AS, et al. Third universal definition of myocardial infarction. Eur Heart J 2012;33:2551–67.

[2] Sandoval Y, Smith SW, Thordsen SE, et al. Supply/demand type 2 myocardial infarction: should we be paying more attention? J Am Coll Cardiol 2014;63:2079–87.

[3] Tehrani DM, Seto AH. Third universal definition of myocardial infarction: update, caveats, differential diagnoses. Cleve Clin J Med 2013;80:777–86.

[4] Saaby L, Poulsen TS, Hosbond S, et al. Classification of myocardial infarction: frequency and features of type 2 myocardial infarction. Am J Med 2013;126:789–97.

[5] Riera AR, Ferreira C, Schapachnik E, et al. Brugada syndrome with atypical ECG: downsloping ST-segment elevation in inferior leads. J Electrocardiol 2004;37:101–4.

[6] Gussak I, Bjerregaard P, Kostis J. Electrocardiographic "lambda" wave and primary idiopathic cardiac asystole: a new clinical syndrome? J Electrocardiol 2004;37:105–7.

[7] Sato A, Tanabe Y, Chinushi M, et al. Analysis of J waves during myocardial ischaemia. Europace 2012;14:715–23.

[8] Aizawa Y, Jastrzebski M, Ozawa T, et al. Characteristics of electrocardiographic repolarization in acute myocardial infarction complicated by ventricular fibrillation. J Electrocardiol 2012;45:252–9.

[9] Cipriani A, D'Amico G, Brunello G, et al. The electrocardiographic "triangular QRS-ST-T waveform" pattern in patients with ST-segment elevation myocardial infarction: Incidence, pathophysiology and clinical implications. J Electrocardiol 2018;51:8–14.

[10] Pérezriera AR, Abreu LC, Yanowitz F, et al. Benign" early repolarization versus malignant early abnormalities: clinical-electrocardiographic distinction and genetic basis. Cardiol J 2012;19:337–46.

[11] Kukla P, Jastrzebski M, Sacha J, et al. Lambda-like ST segment elevation in acute myocardial infarction - a new risk marker for ventricular fibrillation? Three case reports. Kardiol Pol 2008;66:873–7. discussion 877-878.

[12] Yan GX, Joshi A, Guo D, et al. Phase 2 reentry as a trigger to initiate ventricular fibrillation during early acute myocardial ischemia. Circulation 2004;110:1036–41.

[13] Hosseini SM, Kim R, Udupa S, et al. Reappraisal of reported genes for sudden arrhythmic death: evidence-based evaluation of gene validity for Brugada syndrome. Circulation 2018;138:1195–205.

[14] Hu D, Viskin S, Oliva A, et al. Novel mutation in the SCN5A gene associated with arrhythmic storm development during acute myocardial infarction. Heart Rhythm 2007;4:1072–80.