

# The ‘de Winter’ electrocardiogram pattern as a ST-elevation myocardial infarction equivalent: a case report

Thierry Grandjean \*, Sophie Degrauwe, Elena Tessitore , and Juan F. Iglesias 

Department of Cardiology, University Hospital of Geneva, Rue Gabrielle-Perret-Gentil 4, 1205 Geneva, Switzerland

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## Background

A ‘STEMI equivalent’ electrocardiogram (ECG) pattern reflects an acute thrombotic occlusion of a large epicardial coronary artery without ST-segment elevation. These ECG patterns are less known by caregivers.

## Case summary

We describe the case of a 56-year-old patient suffering from acute chest pain, presenting in our emergency department with a ‘de Winter’ ECG pattern: an upsloping ST-segment depression with tall symmetrical T waves associated with left anterior descending artery occlusion.

## Discussion

The ‘de Winter’ ECG pattern, as other ‘STEMI equivalent’, must be recognized promptly and treated as soon as possible with emergent reperfusion by percutaneous coronary intervention.

## Keywords

ST depression with tall symmetrical T waves • ‘de Winter’ • ECG pattern • Acute coronary syndrome • STEMI equivalent • Case report

## Learning points

- A ‘STEMI equivalent’ electrocardiogram (ECG) pattern reflects an acute thrombotic occlusion of a large coronary artery without ST-segment elevation, that must be recognized and treated with emergent reperfusion therapy (percutaneous coronary intervention).
- The ‘de Winter’ sign is a ‘STEMI equivalent’ ECG pattern associated with proximal/mid-left anterior descending artery occlusion.
- It is important to realize serial ECGs when treating patients with acute typical chest pain.

## Introduction

ST-segment elevation myocardial infarction (STEMI) is well recognized with its typical electrocardiogram (ECG) aspects by caregivers working in the pre-hospital settings or in the emergency room, and it is treated with emergent reperfusion therapy according to current guidelines.<sup>1</sup> In parallel, very high-risk non-ST-segment elevation myocardial infarction (NSTEMI) [haemodynamic instability/cardiogenic shock, recurrent/ongoing chest pain refractory to medical treatment, life-threatening arrhythmia/cardiac arrest, mechanical complication of myocardial infarction, acute heart failure, dynamic ST-T waves changes (particularly with intermittent ST-elevation)] should be treated the same way by prompt reperfusion therapy (<2 hours).<sup>2</sup>

\* Corresponding author. Tel: 0041 22 372 33 11. Email: [Thierry.Grandjean@hcuge.ch](mailto:Thierry.Grandjean@hcuge.ch)

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There is also a non-atherogenic cause that can produce transient ST-segment elevation which is the coronary spasm.

There are other ECG patterns, not described in these two categories, associated with acute thrombotic occlusion of a large coronary artery that carries the same prognosis and should be treated emergently. These 'STEMI equivalent' are less known by caregivers resulting often in delayed treatment and more unfavourable outcomes. The 'de Winter' ECG pattern is one of them.

## Timeline

Time	Events
Admission (Day 0)	The patient developed typical chest pain and was brought by ambulance to the emergency room. Pre-hospital electrocardiogram (ECG) (30 min after onset of pain) showed anterior peaked T waves.
Admission + 1–2 hours	There was persisting chest pain under treatment, the ECG (1 hour after onset of pain) showed a de Winter sign and emergent coronary angiography demonstrated a mid-left anterior descending artery occlusion treated with angioplasty and two drug-eluting stents
Day 2	ECG with persisting anterior Q waves and transthoracic echocardiogram with apical akinesia, anterior, and antero-septal hypokinesia with an EF of 48%
Day 4	Evolution without complication. The patient was discharged from hospital.
Day 45	Cardiovascular rehabilitation outpatient program

## Case presentation

A 56-year-old former smoker known for hypertension, dyslipidaemia, and a positive familial history for cardiovascular disease was admitted in our emergency department with acute typical chest pain since 1 hour. Physical exam and vital signs were normal. Pre-hospital ECG performed 30 min after the onset of the chest pain showed tall symmetric T waves in the precordial leads with ST-segment elevation < 2 mm in lead V2–V3 (not meeting STEMI criteria) (Figure 1A). The patient received 250 mg IV of Aspirin in the ambulance. Upon admission in the emergency room, the patient presented persistent chest pain despite nitrates and morphine administration. Repeat ECG (1 hour after the onset of the chest pain) showed dynamic changes with 3 mm upsloping ST-segment depression and tall symmetrical T waves in leads V3–V5 with a 0.5 mm ST-segment elevation in lead aVR (Figure 1B). A 'de Winter' ECG pattern was recognized and furthermore, according to current recommendations, because of persistent typical chest pain refractory to medical treatment ('very high-risk' NSTEMI), emergent coronary angiography was indicated. 180 mg p.o. of Ticagrelor and 5000 UI IV of heparin were

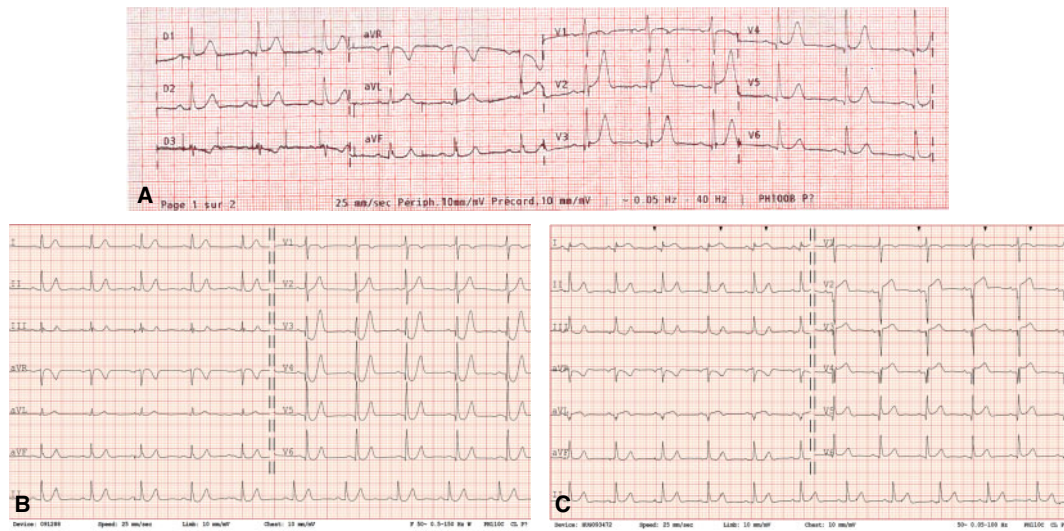
administered. Emergent coronary angiography using a right radial access was performed and showed a single-vessel disease with an occlusion of the mid-left anterior descending artery (LAD) (Figure 2A, B) and non-significant stenosis of the proximal and mid-right coronary artery (RCA) with collaterals to the LAD (Figure 2C). The patient underwent manual thrombus aspiration revealing a long mid-LAD stenosis after removal of fresh thrombus (Figure 3A) (with plaque dissection and residual stenosis after pre-dilatation in Figure 3B), which was successfully treated with implantation of two (4.0 × 38 mm and 4.0 × 12 mm) everolimus-eluting stents (Figure 3C) (Supplementary material online, Video clips). Intravenous abciximab was administered for 12 hours. The ECG recorded after the procedure (5 hours after the pain started) showed an anterior STEMI with Q waves in leads V2–V5 (Figure 1C). Anterior Q waves persisted the next days and corresponded to an apical akinesia, anterior, and antero-septal hypokinesia with an ejection fraction (EF) of 48% (Bi-plan Simpson method) on the echocardiography performed 2 days later (Supplementary material online, Video clips). Clinical evolution was free of complications, and the patient was discharged 2 days after with a dual antiplatelet therapy (aspirin + ticagrelor for 12 months), a statin, a beta-blocker, and an angiotensin converting enzyme (ACE) inhibitor because of the slightly reduced EF and hypertension. A cardiac outpatient rehabilitation program was planned.

## Discussion

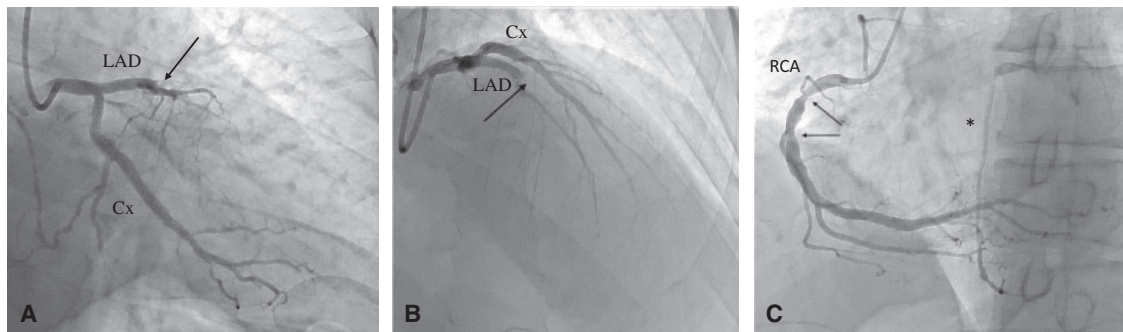
The ECG criteria of STEMI are defined by ST-segment elevation (at the J-point) in V2–V3 ≥ 2.5 mm in men <40 years, ≥2 mm in men ≥40 years, ≥1.5 mm in women, and/or ≥ 1 mm in the other leads in a least two contiguous leads. Right precordial leads should be performed in the setting of inferior STEMI as well as posterior leads when suspecting a posterior STEMI.<sup>1</sup>

A 'STEMI equivalent' ECG pattern reflects an acute thrombotic occlusion of a large coronary artery without the typical ST-segment elevation that must be recognized and treated with emergent reperfusion by percutaneous coronary intervention (PCI). These ECG patterns are found in ~10–20% of patients with an acute myocardial infarction.<sup>3,4</sup> Some STEMI equivalent ECG patterns are described in the ESC guidelines<sup>1</sup> as 'atypical ECG' presentations that should be promptly treated by emergent PCI in patients with ongoing symptoms, consistent with myocardial ischaemia. Those are: right and left bundle branch block (regardless of new or previously known), ventricular paced rhythm, anterior hyperacute T waves as a transient pattern found in the early stage of a coronary occlusion, ST-segment depression in leads V1–V4 [especially when there is a tall R wave in V1 or V2 (R/S ratio > 1 in V1 or V2)],<sup>5</sup> suggesting posterior myocardial infarction that should be searched with posterior leads (V7–V9), and ST-segment depression ≥1 mm in ≥8 leads coupled with ST-segment elevation ≥ 1 mm in aVR or V1 suggesting ischaemia due to left main coronary occlusion or multivessel disease.

Other STEMI equivalent patterns not mentioned above, include the Wellens' syndrome, first described in 1982<sup>6</sup> (inverted or biphasic T waves in V1–V4, mainly V2–V3) specific for proximal LAD occlusion,<sup>5,7</sup> and occlusion of the first diagonal branch of the LAD manifested by ST-segment elevation with upright T waves in leads aVL and V2, and ST-segment depression in leads D3 and aVF.<sup>5,7</sup>



**Figure 1** (A) Pre-hospital electrocardiogram showing peaked T waves in precordial leads, with ST-segment elevation <2 mm in lead V2–V3. (B) Electrocardiogram at the emergency room showing 3 mm upsloping ST-segment depression and persistent tall symmetrical T waves in leads V3, V4, and V5, and a 0.5-mm ST-segment elevation in lead aVR. (C) Electrocardiogram after angiography showing an anterior STEMI with Q waves in leads V2, V3, V4, and V5.

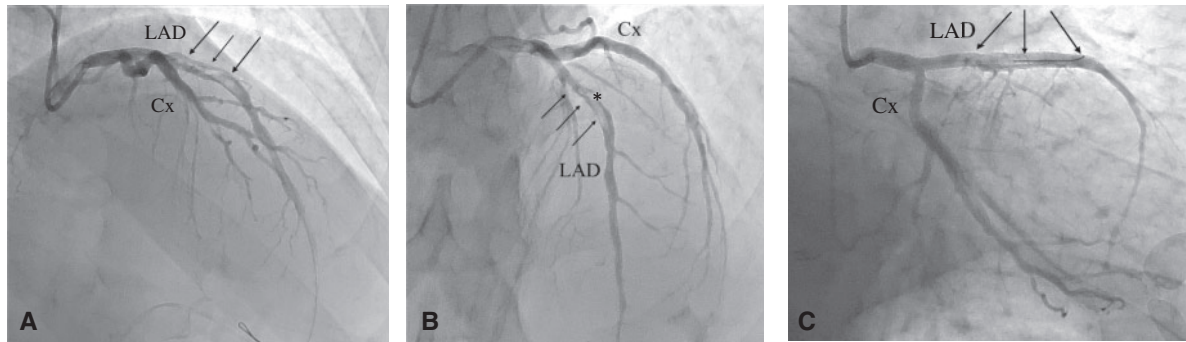


**Figure 2** (A, B) Left coronary angiograms (A: right anterior oblique 23°/Caudal 30°, B: right anterior oblique 30°/Cranial 30°) with thrombotic occlusion of mid-left anterior descending artery (arrow). (C) Right coronary artery angiogram (left anterior oblique 29°/0°) with intermediate stenosis in the proximal and mid-right coronary artery (arrows) and collaterals (\*) to the left anterior descending artery. Cx, left circumflex artery; LAD, left anterior descending artery; LAO, left anterior oblique view; RAO, right anterior oblique view; RCA, right coronary artery.

Our case shows another STEMI equivalent ECG pattern associated with proximal LAD occlusion described for the first time in 2008 by R. The Winter,<sup>8</sup> consisting of a 1–3 mm upsloping ST-segment depression at the J-point in leads V1–V6 with positive symmetrical T waves, and with eventually a slight 1–2 mm ST elevation in aVR. This rare ECG pattern, mostly seen in single-vessel coronary artery disease, was static without overt evolution in a STEMI pattern (disappearance only after revascularization), and it was present in about 2% of anterior myocardial infarction. This ECG pattern is since commonly referred as the ‘de Winter’ syndrome, sign, or ECG pattern. One year later the same team reported in an observational study,<sup>9</sup> the same association with this ECG pattern found in 2% of proximal LAD occlusions (positive predictive value (PPV) 100%). In this study, it was observed that

patients with the ‘de Winter’ sign were more often younger male with hypercholesterolaemia. This was one more time confirmed this year by the Amsterdam team,<sup>10</sup> with the ‘de Winter’ sign present in 1.6% of anterior infarctions, invariably associated with occlusion of proximal or mid-LAD and with a significant male predominance.

The static part of this ECG pattern was already questioned by Goebel *et al.* in 2014.<sup>11</sup> In a recent retrospective study,<sup>12</sup> this specific ECG pattern was described rather as a transient ischaemic phenomena with majority of patients evolving in an overt STEMI, and was found in 3.4% of anterior myocardial infarction, and more commonly associated with multivessel disease. Other groups have found this ECG pattern associated with occlusion of other coronary arteries than the LAD,<sup>3</sup> and in one case without coronary occlusion.<sup>13</sup>



**Figure 3** (A) Left coronary angiogram (RAO 30°/Cranial 30°) after thromboaspiration with residual thrombus and stenosis on left anterior descending artery (arrows). (B) Left anterior descending artery (left anterior oblique 3°/Cranial 43°) with plaque dissection (\*) after pre-dilatation and residual stenosis (arrows). (C) Coronary angiogram (right anterior oblique 29°/Caudal 36°) after percutaneous coronary intervention with two drug-eluting stents to the proximal and mid-left anterior descending artery (arrows). Cx, left circumflex artery; LAD, left anterior descending artery; LAO, left anterior oblique view; RAO, right anterior oblique view.

## Conclusion

The 'de Winter' sign is a rare STEMI equivalent ECG pattern found in 2–3% of anterior myocardial infarction and is associated with LAD occlusion (mostly single-vessel disease). It is found in patients that are generally younger, more often male and suffering from hypercholesterolaemia.

Whether the 'de Winter' ECG pattern is a static ECG pattern or a transient ischaemic phenomena preceding the evolution into an overt STEMI, it emphasizes the importance to realize serial ECGs when treating patients with an acute typical chest pain. In our patient, it is interesting to note that there were hyperacute T waves as an early sign of ischaemia, followed by the typical appearance of the 'de Winter' sign.

The 'de Winter' ECG pattern is not mentioned in the ESC guidelines but it is important to bear in mind this rare ECG pattern that needs, from most expert opinions, to be treated, as other STEMI equivalent, with prompt revascularization therapy. In our opinion, the 'de Winter' ECG pattern and the other 'STEMI equivalents' could be considered and treated as the very high-risk NSTEMI described in the 2015 ESC guidelines.<sup>2</sup>

## Lead author biography



Residency in Internal medicine in 2012–2017. Speciality title in Internal medicine in 2017. Resident in Cardiology since 2017 in Switzerland (Fribourg then Geneva University Hospital).

## Supplementary material

[Supplementary material](#) is available at *European Heart Journal - Case Reports* online.

**Slide sets:** A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

**Consent:** The authors confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

**Conflict of interest:** none declared.

## References

- Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: the Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). *Eur Heart J* 2018;**39**:119–177.
- Roffi M, Patrono C, Collet J-P, Mueller C, Valgimigli M, Andreotti F, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). *Eur Heart J* 2016;**37**:267–315.
- Wall J, White LD, Lee A. Novel ECG changes in acute coronary syndromes. Would improvement in the recognition of "STEMI-equivalents" affect time until reperfusion? *Intern Emerg Med* 2018;**13**:243–249.
- Schmitt C, Lehmann GN, Schmieder S, Karch M, Neumann F-J, SchöMig A. Diagnosis of acute myocardial infarction in angiographically documented occluded infarct vessel: limitations of ST-segment elevation in standard and extended ECG leads. *Chest* 2001;**120**:1540–1546.
- Macias M, Peachey J, Mattu A, Brady WJ. The electrocardiogram in the ACS patient: high-risk electrocardiographic presentations lacking anatomically oriented ST-segment elevation. *Am J Emerg Med* 2016;**34**:611–617.
- de Zwaan C, Bär FW, Wellens HJ. Characteristic electrocardiographic pattern indicating a critical stenosis high in left anterior descending coronary artery in patients admitted because of impending myocardial infarction. *Am Heart J* 1982;**103**(4 Pt 2):730–736.
- Ayer A, Terkelsen CJ. Difficult ECGs in STEMI: lessons learned from serial sampling of pre- and in-hospital ECGs. *J Electrocardiol* 2014;**47**:448–458.

8. de Winter RJ, Verouden NJW, Wellens HJJ, Wilde AAM; Interventional Cardiology Group of the Academic Medical Center. A new ECG sign of proximal LAD occlusion. *N Engl J Med* 2008;**359**:2071–2073.
9. Verouden NJ, Koch KT, Peters RJ, Henriques JP, Baan J, van der Schaaf RJ, Vis MM, Tijssen JG, Piek JJ, Wellens HJ, Wilde AA, de Winter RJ. Persistent precordial “hyperacute” T-waves signify proximal left anterior descending artery occlusion. *Heart Br Card Soc* 2009;**95**:1701–1706.
10. de Winter RW, Adams R, Amoroso G, Appelman Y, ten Brinke L, Huybrechts B, van Exter P, de Winter RJ. Prevalence of junctional ST-depression with tall symmetrical T-waves in a pre-hospital field triage system for STEMI patients. *J Electrocardiol* 2019;**52**:1–5.
11. Goebel M, Bledsoe J, Orford JL, Mattu A, Brady WJ. A new ST-segment elevation myocardial infarction equivalent pattern? Prominent T wave and J-point depression in the precordial leads associated with ST-segment elevation in lead aVr. *Am J Emerg Med* 2014;**32**:287.e5–8.
12. Xu J, Wang A, Liu L, Chen Z. The de Winter electrocardiogram pattern is a transient electrocardiographic phenomenon that presents at the early stage of ST-segment elevation myocardial infarction. *Clin Cardiol* 2018;**41**:1177–1184.
13. García-Izquierdo E, Parra-Esteban C, Mirelis JG, Fernández-Lozano I. The de Winter ECG pattern in the absence of acute coronary artery occlusion. *Can J Cardiol* 2018;**34**:209.e1–209.e3.