

An unusual cause of polymorphic ventricular tachycardia: Acquired long QT syndrome from atypical variant of stress-induced cardiomyopathy

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Abstract

A 55-year-old woman with a recent history of surgically and radioiodine treated thyroid cancer experienced a run of polymorphic ventricular tachycardia with hemodynamic perturbation during anaesthetic induction with propofol, fentanyl and rocuronium for elective surgical excision of right hip metastasis. Electrocardiography showed new T-wave inversion and QT prolongation that subsequently resolved. Cardiac enzymes were elevated but invasive coronary angiography showed unobstructed epicardial coronary arteries. Cardiovascular magnetic resonance showed not only normal biventricular size and systolic function but also a striking pattern of patchy myocardial oedema involving the basal-to-mid anterior, septal and inferior walls and some associated hypertrophy in the anteroseptum (representing focal myocardial swelling from the oedema) but no focal or diffuse myocardial fibrosis. All these abnormalities resolved on subsequent convalescent imaging. A diagnosis of multifactorial acquired long QT syndrome secondary to atypical variant stress-induced cardiomyopathy was made with the likely provoking factors in this case having been the female sex, understandable pre-operative anxiety, anaesthetic drugs, supraglottic airway placement and thyroid dysfunction. An implantable loop recorder during follow-up detected no further significant arrhythmias and she remains well and asymptomatic to date on a low dose of beta-blocker.

Keywords

Cardiovascular, critical care/emergency medicine, cardiomyopathy, ventricular tachycardia, cardiovascular magnetic resonance

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Introduction

Stress-induced cardiomyopathy, classically known as Takotsubo cardiomyopathy, manifests with apical ballooning and an apex-to-base gradient of myocardial oedema (highest at the apex) usually secondary to a major emotional or physical stressor. Its imaging features are quite striking both by echocardiography and cardiovascular magnetic resonance (CMR). However, atypical variants of stress-induced cardiomyopathy are less well understood and only sparsely described. Three atypical variants have been described to date, depending on whether the myocardial abnormalities predominantly affect the basal, mid-ventricular or other focal myocardial regions.¹ In all cases, the myocardial oedema and dysfunction violate the apex-to-base gradient of the classic Takotsubo syndrome.

Here, we report the first case of atypical stress-induced cardiomyopathy causing an acquired long QT syndrome (LQTS)

and polymorphic ventricular tachycardia (VT) during induction for anaesthesia in an understandably anxious patient with deranged thyroid function and thyroid carcinoma. We believe

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our case is special because it illustrates, using state-of-the-art CMR images, how exposure to a combination of seemingly minor ‘stressors’ in a susceptible individual – general anaesthesia and supraglottic airway placement in a middle-aged female with thyroid dysfunction – provided the perfect storm for myocardial injury and malignant ventricular arrhythmia.

Case presentation

A 55-year-old woman with previous total thyroidectomy, selected neck dissection and radioiodine ablation for follicular variant papillary thyroid cancer discovered just 7 months previously, sustained a broad complex tachycardia consistent with VT during anaesthesia induction for elective surgical resection of right acetabular solitary metastasis and cemented total hip replacement. Sedation and general anaesthesia had just been achieved with standard doses of fentanyl, propofol and rocuronium and an I-gel supraglottic device was securing her airway at the time of onset of the VT. The polymorphic VT was observed on monitor (no printouts available) and it caused hemodynamic instability till it was terminated with an intravenous dose of metoprolol. Surgery was abandoned and the patient resuscitated with fluids after which she was transferred to our hospital where she was admitted to our cardiac high-dependency unit with some clinical signs of pulmonary oedema that responded to furosemide. Electrolytes and albumin levels were in normal range (sodium 138 mmol/L, potassium 4.0 mmol/L, unadjusted calcium 2.26 mmol/L, magnesium 0.8 mmol/L and albumin 40 g/L) and D-dimer was negative. She was a non-smoker, with no history of alcohol excess, syncope or family history of cardiomyopathy/sudden death. High-sensitivity Troponin-T reached a maximum of 580 ng/L, serum-free thyroxine (free T4 and fT4) was normal at 19.1 pmol and thyroid stimulating hormone (TSH) purposely suppressed to 0.16 munit/L by a 125 mcg regular oral dose of levothyroxine on account of the thyroid cancer. Aspirin, clopidogrel, bisoprolol and ramipril were commenced. Invasive coronary angiography showed unobstructed coronaries. Electrocardiography (ECG) immediately after resolution of the VT (Figure 1(a)) showed T-wave inversion in I, aVL and V1; QRS fragmentation in V3; early repolarization in II, III, aVF, and V3V6; and prolonged corrected QT interval (QTc, 532 ms), while her pre-operative ECG was essentially normal (not shown). Admission echocardiography showed subtle hypokinesis in the mid-inferoseptum/inferior wall but no apical ballooning to suggest Takotsubo. CMR 2 days later (Figure 2) showed normal biventricular size, good left ventricular (LV) systolic function (ejection fraction 68%), mildly increased LV anteroseptal thickness but normal mass and patchy elevation of native myocardial T1 and T2 times in the basal-to-mid anterior/septal/inferior walls (suggesting oedema) but without late gadolinium enhancement. The earlier hypokinesis observed by echocardiography had by this time resolved. Ward telemetry recorded no arrhythmias and the ECG had normalized prior to discharge (QTc 434 ms)

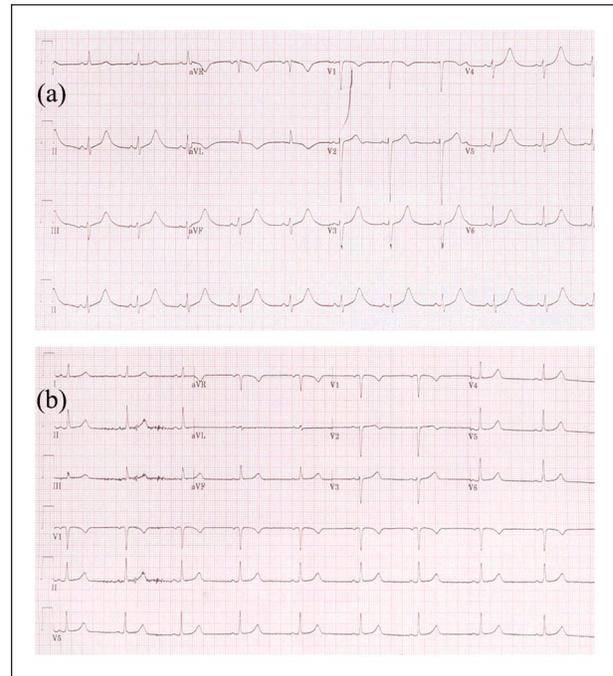


Figure 1. (a) 12-lead ECG immediately after the VT event showing T-wave inversion in I, aVL and V1; QRS fragmentation in V3; early repolarization inferolaterally; and prolonged QTc of 532 ms. (b) Repeat ECG pre-discharge showing persistent T-wave inversion but normal ST segments and normal QT interval of 434 ms.

except for persistent T-wave inversion (Figure 1(b)). She was discharged on bisoprolol and ramipril and implanted with a loop recorder that has detected no arrhythmias to date. CMR 3 months later (Figure 2) showed normalization of all myocardial T1 and T2 times, normal anteroseptal wall thickness and a reduction in LV mass (from 100 to 87 g). Following the abandoned surgery for hip metastasis, her case was discussed at the thyroid multi-disciplinary team meeting and consensus was to treat with 5.5 GBq radioiodine ablation rather than reattempt surgery or localized stereotactic radiotherapy.

Discussion

Stress-induced cardiomyopathy syndromes, whether typical or atypical, all share features of transient regional LV systolic dysfunction mimicking a myocardial infarction in the absence of obstructive epicardial coronary artery disease. The majority of reported cases of stress-induced cardiomyopathy typically follow the classic Takotsubo pattern of LV apical myocardial oedema (high native myocardial T1 and T2) and ballooning of the apical segments with preserved contractility and native myocardial relaxometry in the more basal segments. However, atypical variants are increasingly being recognized, also thanks to the advanced imaging insights provided by CMR. The ‘reverse’ or ‘inverted’ Takotsubo syndrome^{1,2} is one of the atypical variants in

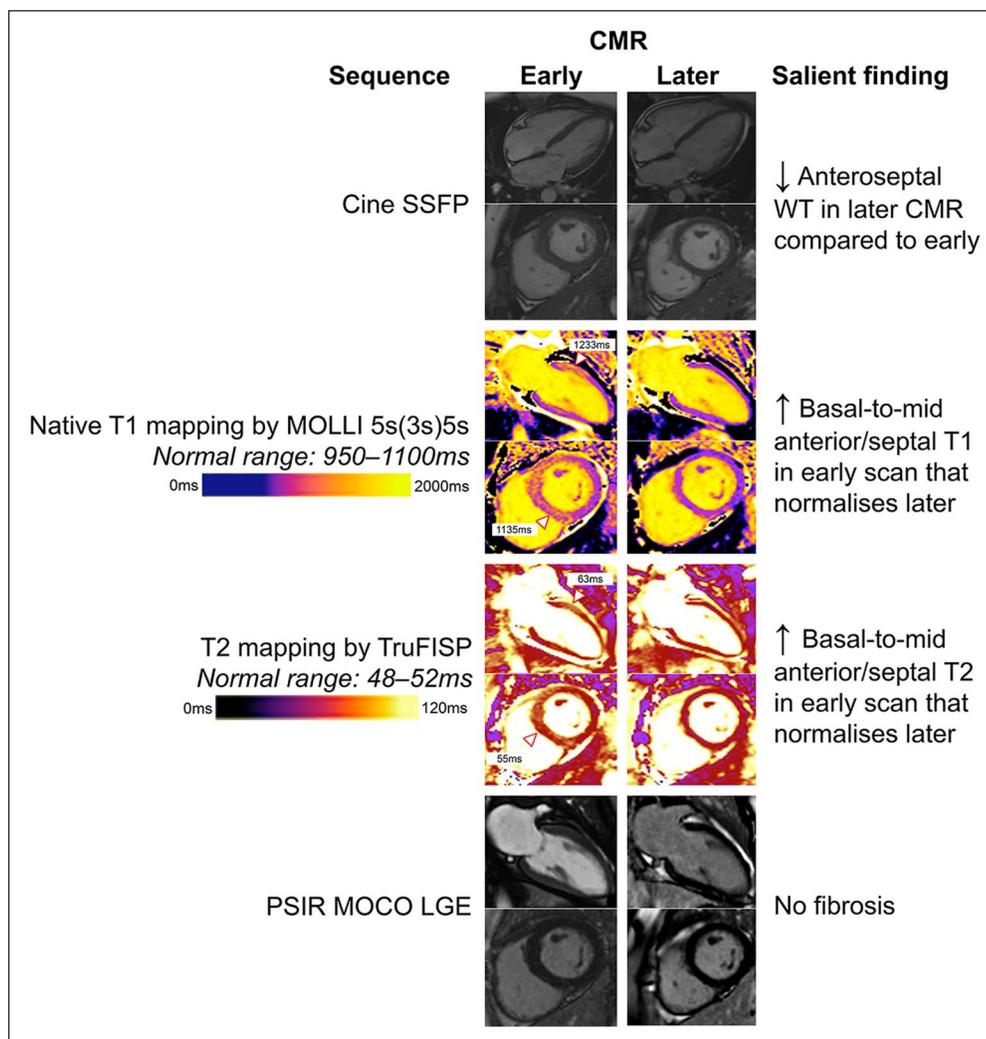


Figure 2. Comparing salient findings between the early CMR scan performed 2 days after the VT event (early column) versus 3 month follow-up scan (later column).

LGE: late gadolinium enhancement; MOCO: motion-corrected; MOLLI: modified look-locker inversion recovery; PSIR: phase-sensitive inversion recovery; SSFP: steady-state free precession; WT: wall thickness.

which the oedema and wall motion abnormality predominate in the basal segments with relative apical sparing or even compensatory apical hyperkinesis. The sudden release of catecholamines following a stressor is thought to be the main trigger for stress-induced cardiomyopathy, and the regional predilection potentially relates to patient-specific patterns of myocardial distribution of beta receptors. ‘Reverse’ Takotsubo has been observed more commonly in younger patients, since adrenoceptors in this age group predominate at the base compared to the apex.³ However, our patient was postmenopausal so the concentration of adrenoceptors by this age is expected to be higher in the apex compared with the base; hence, one might have expected a more classical (apical) pattern of LV dysfunction.⁴

The observed regional wall motion abnormality consisting of mid-inferior/inferoseptal hypokinesis and matching

oedema fitted with an atypical stress-induced cardiomyopathy. Post-cardiac arrest myocardial stunning would have been expected to cause more global hypokinesis, while a microcirculatory flow impairment would have left some visible patch of myocardial fibrosis or signs of microvascular obstruction detectable by CMR, yet we observed none of these.

The opening presentation here was with life-threatening VT that is somewhat unusual for a stress-induced cardiomyopathy, where more commonly described presentations are those of chest pain mimicking myocardial infarction or new onset heart failure with or without cardiogenic shock.⁵ The real prevalence of arrhythmias in stress-induced cardiomyopathy is, in fact, unknown. The reported rate of ventricular fibrillation reportedly ranges from 1.5% to 15%.^{6–8} Sudden cardiac death has been reported as the first clinical

presentation of Takotsubo cardiomyopathy, suggesting that the incidence of malignant ventricular arrhythmias is probably underestimated.

Stress-induced cardiomyopathy has been previously linked to the pre-operative period⁹ but the pathophysiological mechanisms are unclear and a wide range of anaesthetic agents have been implicated including methohexital, succinylcholine, sulfentanyl, propofol and atracurium.^{10–12} In our patient, surgery on the hip metastasis had not yet commenced so inadequate depth of anaesthesia could not have been the trigger. Similarly, she was fitted with a supraglottic airway not requiring tracheal manipulation so that was unlikely to have been the stimulus.

Her QT interval was normal pre-operatively and it normalized soon after the event indicating that the LQTS had been acquired. While it remains possible that the transient QT prolongation may have been drug-induced, this alone would not have explained the striking CMR findings of patchy myocardial oedema. The sedoanalgaesic fentanyl should have been protective as it reduces catecholamine release, but its impact on the QTc remains controversial.¹³ Data on the effect of propofol on the QTc are also conflicting^{14,15} while rocuronium at conventional doses, like that used in our patient, is not known to cause QTc prolongation.¹⁶ Though hyperthyroidism has been previously implicated in QTc prolongation, the association only held true for high fT4 (hers was normal) and not for suppressed levels of TSH.¹⁷ Overall, we think that here an atypical stress-induced cardiomyopathy was responsible for the multifactorial QT interval prolongation and that the heterogeneity in dispersion of repolarization may have led to phase 2 reentry and the polymorphic VT. This is in keeping with similar reports recognizing the role of classical Takotsubo as a cause of acquired and often transient LQTS in the setting of multiple risk factors.¹⁸

Conclusion

Atypical variants of stress-induced cardiomyopathy may sometimes present catastrophically and although rare, it is an important differential to bear in mind in patients with acquired LQTS or those presenting with malignant ventricular arrhythmias. Deep phenotyping using CMR has the potential to uncover unusual patterns of myocardial oedema that can clinch the diagnosis if performed sufficiently early and offers the possibility of follow-up to confirm resolution of findings.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

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Informed consent

Written informed consent was obtained from the patient for her anonymized information to be published in this article. The signed written informed consent form is available for review if required.

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