Direct current cardioversion-triggered atypical Tako-tsubo cardiomyopathy: a case report and review of literature

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Background

Tako-tsubo stress cardiomyopathy is a clinical syndrome marked by transient reduction of left ventricular function in the setting of emotional or physical stress and in the absence of obstructive coronary artery disease. We describe a case of an atypical variant of Tako-tsubo in a male patient following an elective direct current cardioversion (DCCV).

Case summary

A 78-year-old male whose atrial fibrillation persisted after earlier unsuccessful direct current DCCV and radiofrequency ablations presented to the emergency department for acutely worsening dyspnoea and orthopnoea 12 h following his most recent DCCV. Previously, he was known to have non-obstructive coronary artery disease. Evaluation was notable for troponin I 0.019 ng/mL (negative <0.050 ng/mL), pro-brain natriuretic peptide 2321 pg/mL (reference range 0.0–900 pg/mL). There were no acute electrocardiogram abnormalities. He required bilevel positive airway pressure but was weaned off eventually to room air. Transthoracic echocardiogram revealed newly reduced left ventricular ejection fraction of 45–50%, associated with hypokinesis of the basal anteroseptal segment, as well as akinesis of mid-inferoseptal and mid-anteroseptal segments. Apical contractility was preserved. On Day 5 of hospitalization, diagnostic left heart catheterization again revealed benign coronary anatomy, and he was discharged home the following day.

Discussion

Only five other cases of cardioversion mediated Tako-tsubo cardiomyopathy have been reported in the literature. To our knowledge, this is the first case of DCCV-induced atypical Tako-tsubo cardiomyopathy. Although overall prognosis is favourable, some have been observed to require advanced support therapy. Given risk for life-threatening complications, patients undergoing cardioversion should be educated on symptoms of congestive cardiomyopathy.

Keywords

Atypical Tako-tsubo • Atrial fibrillation • Cardioversion • Case report • Pulmonary oedema • Stress cardiomyopathy • Tako-tsubo cardiomyopathy

ESC Curriculum

5.3 Atrial fibrillation • 6.2 Heart failure with reduced ejection fraction • 6.4 Acute heart failure

Learning points

• Acute pulmonary oedema and Tako-tsubo syndrome are rare complications of cardioversion that can be life threatening.
• Variant forms of Tako-tsubo cardiomyopathy are categorized by involvement of different regions of the left ventricle including sparing of the apex.
Introduction

Tako-tsubo cardiomyopathy is an acute and reversible form of cardiomyopathy that mimics an acute coronary event and was first described by Sato et al. in 1990.1 Preceding emotional or physical stress is a classic predisposing factor, and the syndrome is most prevalent in post-menopausal women.2 A wide range of triggers has been described, yet there are only five reported cases of Tako-tsubo syndrome following direct current cardioversion (DCCV).3–7

In this case report, we describe a case of an anatomically atypical variant of Tako-tsubo in a 78-year-old male following an elective DCCV for persistent atrial fibrillation. To our knowledge, this is the first case of DCCV-induced atypical Tako-tsubo cardiomyopathy.

Timeline

| Hospital day | Events |
|--------------|--------|
| Morning prior to admission | Successful elective direct current cardioversion (DCCV) to sinus rhythm |
| Day 0, emergency department | Admitted to intermediate care unit due to 12 h of progressively worsening dyspnoea following elective DCCV conducted earlier that morning |
| Day 1, intermediate care unit | Electrocardiogram: sinus rhythm. No acute ST-changes. Chest X-ray: cardiomegaly and pulmonary oedema Oxygen requirements: bilevel positive airway pressure Transthoracic echocardiogram (TTE): left ventricular ejection fraction (LVEF) 45–50%, hypokinesia of basal anteroseptal segment, as well as akinesis of mid inferoseptal and mid anteroseptal segments New treatment: carvedilol, spironolactone Oxygen requirement: 2 L of oxygen via nasal cannula (NC) Lab: international normalized ratio 2.12–1.73 New treatment: intravenous heparin Oxygen requirement: 3 L of oxygen via NC |
| Day 3, intermediate care unit | Oxygen requirement: room air Lab: international normalized ratio 2.12–1.73 New treatment: intravenous heparin Oxygen requirement: 3 L of oxygen via NC |
| Day 4, intermediate care unit | Oxygen requirement: room air |

Case presentation

A 78-year-old male with a history of persistent atrial fibrillation, hypertension, Stage 3 chronic kidney disease, non-obstructive coronary artery disease (2018), thoracic aortic aneurysm (4.5 cm), and Gilbert syndrome presented with progressively worsening dyspnoea, orthopnoea, and wheezing for 12 h following elective DCCV conducted earlier that morning. The patient had prior DCCV attempts and radiofrequency ablation that were unsuccessful on a longitudinal basis.

The patient was afebrile, and his vital signs included pulse 95 beats/minute (b.p.m.), blood pressure 177/94 mmHg, respiratory rate 34 breaths/minute, and oxygen saturation 90% on room air that improved with bilevel positive airway pressure. Physical exam was notable for reduced breath sounds throughout his thorax with visible rib cage retractions during inspiration and an inability to complete full sentences. No peripheral oedema was seen.

Initial labs were notable for white blood count of 17.9 × 10⁹/µL, creatinine 1.39 mg/dL (baseline), total bilirubin 2.8 mg/dL, direct bilirubin 0.5 mg/dL, troponin I 0.019 ng/mL (<0.050 = negative; 0.050–1.50 = indeterminate; >1.50 = positive), pro-brain natriuretic peptide 2321 pg/mL, and international normalized ratio (INR) 3.24. Severe acute respiratory syndrome coronavirus 2 polymerase chain reaction was negative. Electrocardiogram (ECG) showed normal sinus rhythm at heart rate of 72 b.p.m. without any acute ST-changes (Figure 1). Chest radiograph demonstrated interval development of moderate cardiomegaly and prominent pulmonary oedema without pleural effusion (Figure 2). In the emergency department, he was given furosemide 40 mg intravenously.

On hospital day (HD) 1, the patient’s white blood cell count normalized to 9.7 × 10⁹/µL, INR was 3.49, and troponin I peaked at 0.173 mg/mL. His respiratory status improved, and he was transitioned to 2 L of oxygen via nasal cannula. Transthoracic echocardiogram (TTE) showed newly reduced left ventricular ejection fraction (LVEF) of 45–50%, moderate concentric left ventricular (LV) hypertrophy, bialtral enlargement, hypokinesia of apical septum and basal anteroseptal segment, as well as akinesis of mid inferoseptal and mid anteroseptal segments. In contrast to the typical Tako-tsubo pattern,
APICAL CONTRACTILITY was preserved (Video 1, Table 1). Transthoracic echocardiogram performed 1 year prior had shown normal LVEF and no evidence of any wall motion abnormalities. He was continued on sotalol 160 mg two times daily, diltiazem 180 mg daily as needed, losartan 25 mg daily and furosemide 40 mg daily. His home regimen had included metoprolol tartrate 50 mg two times daily, but this medication was discontinued as both spironolactone 25 mg daily and carvedilol 12.5 mg two times daily were added to his regimen. On HD 3, intravenous heparin was started because of subtherapeutic INR. The patient was weaned off supplemental oxygen, and on HD 5, diagnostic left heart catheterization demonstrated no evidence of obstructive coronary artery disease. The patient was resumed on warfarin 3 mg daily, and diltiazem 180 mg daily as needed was discontinued. The patient was discharged home on HD 6 with scheduled outpatient cardiology follow-up. Repeat TTE at 2 months showed restoration of LVEF at 60% with no regional wall motion abnormalities (Video 2, Table 1).

**Discussion**

This is the first reported case of an atypical variant Tako-tsubo stress cardiomyopathy diagnosed after DCCV, and the second reported case of post-DCCV stress cardiomyopathy in a male patient. Based on review of the cardiovascular literature, the typical variant of Tako-tsubo with apical impairment has been observed in 75–80% of all Tako-tsubo cases. It typically manifests as transient LV dysfunction associated with ECG changes such as ST-segment elevation or depression, T-wave inversion, or QTc prolongation, and moderately elevated levels of cardiac biomarkers. Diagnosis of Tako-tsubo may be challenging especially with rare or atypical presentations. In order to improve specificity of Tako-tsubo cardiomyopathy diagnosis, new
international diagnostic criteria (InterkTAK Diagnostic Criteria) has been introduced with score of greater than 50 specific for Tako-tsubo diagnosis.\textsuperscript{9} Our patient’s score was 25.

The pathophysiology of Tako-tsubo syndrome after DCCV is not well established, but proposed hypotheses include (i) acute myocardial injury or myocardial stunning arising from catecholamine release;\textsuperscript{10} (ii) ischaemia-induced myocardial stunning secondary to microvascular or multi-vessel vasospasm;\textsuperscript{11} and (iii) direct injury of the myocardium by the shock current.\textsuperscript{12} An animal study modelling Tako-tsubo demonstrated high serum epinephrine levels with apical-basal gradient in pleiotropic \( \beta_2 \)-adrenoreceptors in the setting of apical myocardial depression, which is consistent with the typical echocardiogram findings in Tako-tsubo syndrome.\textsuperscript{13}

We reviewed characteristics of all six reported cases of DCCV-induced Tako-tsubo syndrome to identify potential associations (Table 2). Consistent with the known female predominance, 66% (4 of 6) were women with mean age of 77 years (age range 67–87). Underlying rhythm was most commonly atrial fibrillation (5 of 6), and mean troponin I was 1.49 ng/mL (range 0.173–3.39 ng/mL). Time to presentation at the emergency department post-DCCV ranged from immediately after the procedure to 36 h (mean of 14.5 h). Interestingly, all six patients had other underlying cardiac conditions in addition to atrial fibrillation. Despite their advanced age, all patients survived to hospital discharge with eventual restoration of LV function.

Acute pulmonary oedema is a rare complication seen after DCCV with only 30 cases reported in the medical literature.\textsuperscript{11} In addition to pulmonary oedema, our patient demonstrated atypical features of Tako-tsubo syndrome including male gender, absence of significant troponaemia, absence of ischaemic ECG changes, and presence of multiple regional wall motion abnormalities with apical sparing, which posed a challenge in determining the diagnosis. Myocarditis was considered as an alternative diagnosis but was deemed unlikely due to the absence of ECG changes, lack of infectious prodrome, insignificant troponaemia, presence of regional wall motion abnormalities, the rapid onset of symptoms after DCCV, and similarly quick improvement in symptoms without the use of anti-inflammatory therapies. Interestingly, all previously reported cases of Tako-tsubo syndrome post-DCCV required either pressor support, mechanical ventilation, or both, yet our patient did not require advanced supportive therapy.

Medical therapy for Tako-tsubo cardiomyopathy is based on the presence or absence of haemodynamic stability and other complications. Patients who like our case have complications such as acute heart failure without LV outflow tract obstruction should receive diuretics, angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blocker, and beta-blockers. However, in comparison to the mortality benefit seen in other types of heart failure, therapy with beta-blockers and ACE inhibitors do not confer significant survival benefit in patients with Tako-tsubo cardiomyopathy.\textsuperscript{14,15} In addition, only ACE inhibitors were shown to help prevent the recurrence of Tako-tsubo induced cardiomyopathy.\textsuperscript{16} The role of aldosterone antagonists have not been well-established, but they have been hypothesized to be potentially cardioprotective due to anti-catecholamine effects.\textsuperscript{17} Guidelines on the duration of treatment are lacking, but patients are typically treated for 4 weeks until improvement of LVEF is seen. There are no studies that have evaluated the role of goal-directed medical therapy on atypical variant Tako-tsubo. Our patient was transitioned to carvedilol for additional blood pressure control, diuretics for optimization of fluid status and symptomatic relief, and spironolactone for anti-catecholamine effect. He was continued on this regimen for 2 months with restoration of LVEF.

| Table 1 | Comparison of transthoracic echocardiogram parameters on initial admission and at 3-month follow-up |
|---------|--------------------------------------------------|
|         | Initial TTE | TTE 3 months post-discharge |
| LVEDV   | 160         | 103                       |
| Normal reference range for male (62–150 mL) |
| LVESV   | 68          | 22                        |
| Normal reference range for male (21–61 mL) |
| LVEF (%)| 45–50       | 60                        |
| Wall motion abnormalities | Akinesis of mid inferoseptal and mid anteroseptal segments. Apical sparing | None |

LVEDV, left ventricular end-diastolic volume; LVEF, left ventricular ejection fraction; LVESV, left ventricular end-systolic volume; TTE, transthoracic echocardiogram.
| Case | Age | Gender | Past medical history | Underlying rhythm prior to DCCV | Symptoms/signs | Peak troponin I (ng/mL) | ECG on admission | Hour to ED presentation post-DCCV | Transthoracic echocardiogram | Coronary angiography | Treatment | Complications and outcome | Reference |
|------|-----|--------|----------------------|-------------------------------|----------------|------------------------|-----------------|-------------------------------|-----------------------------|------------------|------------|---------------------------|------------|
| 1    | 81  | Female | Hypertension, hyperlipidaemia | Atrial fibrillation | Chest pain, dyspnoea, transient aphasia and left arm/leg weakness | 1.14 | SR with prominent TWI V2–V6 | Approximately 24h | New LVEF 32%, akinesia of apical LV and mid-segment; hyperdynamic basal segments and severe MR | Absence of coronary disease |  | Lasix gtt, heparin gtt, antiplatelet medication, dobutamine, and dopamine gtt. BiPAP | Vizzardi et al.2 |
| 2    | 76  | Female | Hypertension, hyperlipidaemia | Atrial fibrillation | Dizziness, diaphoresis, near-syncope | 0.2 | SR, LAFB, and bifid T wave in anteroseptal leads. QTc 537 ms | 10h | New EF 45%, apical and mid-segment akinesia with hyperdynamic basal segments | 30% mid-LAD and 30% mid RCA lesions |  | Aspirin, furosemide, and topical GTN | Eggleton et al. |
| 3    | 67  | Female | Hypertension | Atrial fibrillation | Chest pain, shortness of breath, severe respiratory failure | 3.39 | Atrial fibrillation, HR 126 bpm, low voltage, QTc prolonged | Immediate | New LVEF 13%, contraction only on basal segments with ballooning appearance | Non-CT angiogram 2 years prior was normal |  | DC cardioversion (200 J), Furosemide | Siegfried et al. |
| 4    | 73  | Male   | Hypertension, hyperlipidaemia | Atrial flutter | Sinus tachycardia (HR 105), QTc prolonged | 1.3 | New LVEF 45–50%, LVH, hypokinesis of the basal anteroseptal segment, as well as akinesia of mid-inferoseptal and mid-inferolateral segments | Non-obstructive | New antero-apical akinesia | Non-obstructive | Anticoagulation, beta-blockers | McCutcheon et al. |
| 5    | 87  | Female | Hypertension, hyperlipidaemia, asthma, CKD | Atrial fibrillation | Pulmonary oedema | 2.79 | New LBBB | Approximately 36h | New antero-apical akinesia | Non-obstructive | Mechanical ventilation, atrial fibrillation |  |
| 6    | 78  | Male   | Hypertension, hyperlipidaemia, coronary artery disease, thoracic aortic aneurysm | Atrial fibrillation | Dyspnoea, orthopnoea, wheezing | 0.173 | Normal sinus rhythm, LAD | 12h | New LVEF 45–50%, LVH, hypokinesis of the basal anteroseptal segment, as well as akinesia of mid-inferoseptal and mid-inferolateral segments | Non-obstructive | Lasix, nitroglycerine, beta blocker, ACE-I inhibitor | None | Author’s case |

CT, contrast tomography; GTN, nitroglycerine; HR, heart rate; LAD, left axis deviation; LAFB, left anterior fascicular block; LBBB, left bundle branch block; LVEF, left ventricular ejection fraction; LVH, left ventricular hypertrophy; QTc, corrected QT; SR, sinus rhythm; TTE, transthoracic echocardiogram; TWI, T-wave inversion; WMA, wall motion abnormality.
seen on follow-up TTE. Spironolactone and sotalol were discontinued.

Patients with Tako-tsubo syndrome generally have a good prognosis. An outcomes study assessing trends of hospitalized patients with Tako-tsubo cardiomyopathy demonstrated in-hospital mortality rate of 1.3% [95% confidence interval (CI) 1.1–1.6], hospital discharge rate to home of 73.6% (95% CI 72.7–74.6), and 1-year mortality of 6.9% (95% CI 6.4–7.5). Consistent with the prior case experiences of post-DCCV Tako-tsubo syndrome, our patient survived hospitalization and was discharged home without the need for post-acute care services. Repeat TTE at 2 months showed complete global and regional restoration of LV function.

Conclusion

Given the potential need for inpatient care, patients undergoing DCCV should be taught to recognize symptoms of acute pulmonary oedema to allow for earlier detection of rare but serious complications of cardiomyopathy. Clinicians should be aware of atypical presentations of Tako-tsubo and consider them when using InterTAK Diagnostic Criteria as those criteria have not been validated on atypical variant Tako-tsubo syndrome. We propose future study into whether variants of Tako-tsubo differ in severity of disease when compared against typical Tako-tsubo; further studies should be sought to evaluate mortality benefit of standard heart failure medications in atypical variant Tako-tsubo cardiomyopathy. A better understanding of the potential benefit of medical therapy would allow clinicians to accurately weigh the relative benefits and risks of procedural interventions.

Lead author biography

Ju Young Bae, MD is a third-year internal medicine resident at Yale-New Haven Health Greenwich Hospital in Connecticut. She will be pursuing fellowship training in cardiovascular medicine at Yale University/Bridgeport Hospital.

Supplementary material

Supplementary material is available at European Heart Journal - Case Reports online.

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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 images and associated text has been obtained from the patient in line with COPE guidance.

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