



Usefulness of ECG to differentiate Takotsubo cardiomyopathy from acute coronary syndrome



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ARTICLE INFO

Article history:

Received 16 April 2015

Received in revised form 28 May 2015

Accepted 10 July 2015

Available online 14 July 2015

Keywords:

Electrocardiogram

Takotsubo cardiomyopathy

Apical ballooning syndrome

Acute myocardial infarction

Acute coronary syndrome

ABSTRACT

Objective: We aimed to describe the evolution of ECG changes in TC compared with MI, and evaluate ECG features which might help to distinguish between these conditions.

Background: Takotsubo cardiomyopathy (TC) can mimic both ST-elevation (STEMI) and non-ST-elevation myocardial infarction (NSTEMI) but management is different. Several electrocardiographic (ECG) abnormalities have been identified which might help to differentiate TC with and without ST-elevation, from STEMI and NSTEMI, respectively.

Methods: We prospectively identified 100 consecutive patients with TC and 100 MI patients. They were divided into 2 groups according to the presence of ST-segment elevation (STE). Serial ECGs from admission to Day 2 were compared.

Results: Thirty-five TC patients had STE on admission. Compared with STEMI patients they had less prominent STE (median peak elevation 2 mm vs. 3 mm, $P < 0.05$), less reciprocal ST-segment depression and no abnormal Q-waves. By Day 2 all STEMI patients had pathological Q-waves but none of the TC patients.

Compared with NSTEMI patients, NSTEMI patients had more ST-segment depression (28.2% vs. 0%, $P < 0.05$), but less T-wave inversion (33.8% vs. 11.3%, $P < 0.05$) on admission. By Day 2 the ECG criterion which best distinguished NSTEMI from NSTEMI was the presence of T-wave inversion in ≥ 6 leads (sensitivity 74%, specificity 92%).

Conclusion: ECG changes seen in TC within two days of presentation are distinctive and important clues for clinicians to suspect the diagnosis.

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1. Introduction

Takotsubo cardiomyopathy (TC) (also known as apical ballooning syndrome) is characterised by acute but rapidly reversible left ventricular (LV) dysfunction in the absence of obstructive coronary disease [1,2]. At presentation TC typically mimics an acute myocardial infarction (AMI) and the initial electrocardiogram (ECG) exhibits ST-segment elevation in about a third of patients [3–5]. Because the in-hospital management of TC and AMI, both with and without ST-segment elevation is distinct, it would be useful to identify ECG features which facilitate the distinction between TC with and without ST-segment elevation, and

ST-elevation myocardial infarction (STEMI) and non-ST-elevation MI (NSTEMI), respectively. Several ECG features of TC have been reported which may help to make these distinctions. These include absence of reciprocal changes, absence of abnormal Q-waves, absence of ST-segment elevation in lead V1, progressive QTc interval prolongation and widespread T-wave inversion [6–8].

Our aim was to examine the serial ECG patterns in TC patients, compare them with both STEMI and NSTEMI patients to identify the ECG features that may distinguish between these diagnoses, and evaluate their discriminative value both at admission and on Day 1 or 2 after admission.

2. Methods

2.1. Study population

The study population was prospectively identified from 3 coronary care units in the public hospitals in Auckland region (Middlemore Hospital, Auckland City Hospital and North Shore Hospital) between March 2004 and July 2010. One hundred consecutive patients who fulfilled the TC diagnostic criteria proposed by the Mayo Clinic group [9] and 100 patients presented with AMI (as described in the Third University Definition of Myocardial Infarction) [10] were identified. ECGs on admission, Day 1 and Day 2 were compared.

Abbreviations: TC, Takotsubo cardiomyopathy; AMI, acute myocardial infarction; ACS, acute coronary syndrome; STE-TC, Takotsubo cardiomyopathy with ST-segment elevation; NSTEMI, Takotsubo cardiomyopathy with non-ST-segment elevation; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; ECG, electrocardiogram.

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¹ The authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

Table 1
Baseline characteristics of Takotsubo cardiomyopathy patients and patients with myocardial infarction.

	STE-TC (n = 35)	STEMI (n = 29)	P value
Female, n (%)	34 (97.1)	4 (13.8)	<0.01
Age (years)	63.3 ± 13.0	56.5 ± 4.62	<0.01
Mean ± SD			
Hypertension, n (%)	12 (34.3)	14 (48.3)	0.26
Dyslipidaemia, n (%)	12 (34.3)	18 (62.1)	0.03
Diabetes mellitus, n (%)	4 (11.4)	7 (24.1)	0.18
Current smoker, n (%)	8 (22.9)	9 (31.0)	0.46
Elevated troponin on admission, n (%)	30 (85.7)	23 (79.3)	0.17
	NSTE-TC (n = 65)	NSTEMI (n = 71)	P value
Female, n (%)	61 (93.8)	21 (29.6)	<0.01
Age (years)	65.5 ± 9.82	55.6 ± 7.41	<0.01
Mean ± SD			
Hypertension, n (%)	23 (35.4)	29 (40.8)	0.51
Dyslipidaemia, n (%)	17 (26.2)	32 (45.1)	0.02
Diabetes mellitus, n (%)	7 (10.8)	15 (21.1)	0.10
Current smoker, n (%)	8 (12.3)	22 (31.0)	0.01
Elevated troponin on admission, n (%)	56 (86.2)	64 (90.1)	0.47

NSTE-TC, Takotsubo cardiomyopathy with non-ST-segment elevation; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; STE-TC, Takotsubo cardiomyopathy with ST-segment elevation; STEMI, ST-segment elevation myocardial infarction.

2.2. ECG recording

A standard 12-lead ECG was obtained at the time of hospital presentation, the next day (Day 1) and the subsequent day (Day 2). All ECGs were recorded at a paper speed of 25 mm/s with a 10-mm/mV amplification scale. ST-segment elevation was defined as a new ST elevation ≥ 0.1 mV (≥ 1 mm) in all leads other than V₂ and V₃ at the J point in ≥ 2 contiguous leads. Peak ST-segment elevation on admission was measured and classified into distribution of coronary arteries i.e. anterior (leads I, aVR and V₂₋₄), inferior (leads II, III and aVF) and lateral leads (leads I, aVL and V₅₋₆). Peak ST-segment elevation

in any lead was also measured. Maximum QT interval was measured in lead V₂ or V₅ [11] and QTc interval was calculated using Bazett's formula (QTc = QT/square root RR interval). Q-waves were considered pathological if ≥ 0.02 s (or QS complex) in leads V₂, V₃, and ≥ 0.03 s and 1.0 mm deep (or QS complex) in leads I, aVL, V₄ to V₆, II, III, and aVF. T-wave inversion (TWI) was defined as negative T-waves > 0.5 mm in amplitude and peak TWI was measured according to coronary artery territories and in any lead. The total number of leads meeting criteria for TWI was recorded. Reciprocal changes were defined as ≥ 1 mm ST-segment depression in at least 2 opposing leads i.e. ≥ 2 inferior leads for anterior STEMI, or ≥ 2 anterior leads for inferior STEMI.

Table 2
Comparison of electrocardiographic findings between STE-TC and STEMI patients.

Variables	Admission			Day 1			Day 2		
	STE-TC (n = 35)	STEMI (n = 29)	p value	STE-TC (n = 35)	STEMI (n = 29)	p value	STE-TC (n = 35)	STEMI (n = 29)	p value
ST-segment elevation ≥ 1 mm									
ST-segment elevation, n (%)				-	-		-	-	
Anterior	31 (88.6)	14 (48.3)	<0.001						
Inferior	11 (31.4)	13 (44.8)	0.270						
Lateral	14 (40.0)	7 (24.1)	0.179						
Reciprocal ST-segment depression, n (%)	0 (0)	6 (20.7)	0.005	-	-		-	-	
Q waves (%)	0 (0)	16 (55.2)	<.0001	0 (0)	28 (96.6)	<.0001	0 (0)	29 (100)	<.0001
T-wave inversion ≥ 0.5 mm, n (%)									
Anterior leads	3 (8.6)	3 (10.3)	1.000	15 (42.9)	7 (24.1)	0.139	23 (65.7)	7 (24.1)	<.0001
Inferior leads	2 (5.7)	2 (6.9)	1.000	16 (45.7)	4 (13.8)	0.008	21 (60.0)	10 (34.5)	0.003
Lateral leads	3 (8.6)	1 (3.5)	0.619	17 (48.6)	4 (13.8)	0.004	23 (65.7)	6 (20.7)	<.0001
Number of leads with TWI	0 (0–0)	0 (0–0)	0.603	2 (0–8)	0 (0–2.5)	0.024	8 (7–10)	2 (1–3)	<.0001
Median (IQR)									
ST-segment magnitude (mm)									
^a Peak ST-segment anterior leads	2 (1.5–3)	4 (3–6)	0.001	-	-		-	-	
Median (IQR)									
^b Peak ST segment inferior leads	1 (1–2)	3 (3–3)	0.002	-	-		-	-	
Median (IQR)									
^c Peak ST segment lateral leads	1.5 (1.5–2)	2.5 (2–5)	0.055	-	-		-	-	
Median (IQR)									
Peak ST segment any lead	2 (1.5–3)	3 (2.5–4)	<0.001	-	-		-	-	
Median (IQR)									
Peak TWI any lead (mm)	0 (0–0)	0 (0–0)	0.512	1 (0–4)	0 (0–3)	0.2035	5 (4–9)	4 (2–5)	0.003
Median (IQR)									
QTc interval (ms)	450 (424–465)	440 (418–471)	0.893	462 (440–505)	444 (434–472)	0.1485	519 (487–542)	459 (417–516)	0.011
Median (IQR)									
ΔQTc interval from admission (ms)									
Day 1 – Admission	33 (2–67)	0 (–16.5–30)	0.059						
Day 2 – Admission	86 (43–119)	31 (–6–81)	0.013						

STE-TC, Takotsubo cardiomyopathy with ST-segment elevation; STEMI, ST-segment elevation myocardial infarction; TWI, T-wave inversion.

^a STE-TC anterior leads vs. anterior STEMI.

^b STE-TC inferior leads vs. inferior STEMI.

^c STE-TC lateral leads vs. lateral STEMI.

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