



Delayed Normalization of Electrocardiograms in Patients with Takotsubo Cardiomyopathy due to Aneurysmal Subarachnoid Hemorrhage

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■ **BACKGROUND:** Takotsubo cardiomyopathy (TCM) is caused by excessive physical and mental stress, and sometimes causes potentially fatal arrhythmias such as torsades de pointes. This study characterized the features of TCM due to aneurysmal subarachnoid hemorrhage, particularly the delayed normalization of electrocardiograms compared with that of transthoracic echocardiograms.

■ **METHODS:** Ten patients with TCM were selected from the 450 patients with subarachnoid hemorrhage treated in our hospital between January 2007 and November 2015. We retrospectively examined these 10 patients with regard to various factors, including durations of abnormal electrocardiographic and echocardiographic findings.

■ **RESULTS:** All 10 patients were women. Mean age at diagnosis was 69.3 years (range, 40–90 years). Electrocardiographic findings were as follows: inverted or flattened T waves (100%); QTc prolongation >0.45 seconds (90.0%); ST segment elevation (60.0%); and ST segment depression (20.0%). Echocardiograms showed typical findings of TCM in 9 cases and inverted TCM in 1 case. In 1 case, ventral fibrillation was observed. Normalization of electrocardiograms was consistently delayed compared with that of echocardiograms, by more than 3 weeks in at least 5 cases (50%). If follow-up of electrocardiographic parameters is discontinued at the point of normalization of wall motion and the end of the vasospasm period, fatal arrhythmia may occur in the aftermath.

■ **CONCLUSIONS:** This study showed a notable delay in recovery of abnormal electrocardiographic findings compared with the recovery of echocardiographic findings.

Sufficient attention to persistent abnormalities on electrocardiography is warranted, even after improvements in cardiac wall motion and the vasospasm period.

INTRODUCTION

Takotsubo cardiomyopathy (TCM) was first reported by Sato et al¹ in 1990, as a clinical condition brought on by excessive psychosomatic stress. Excessive catecholamine concentrations and microcirculation disorder, among others, have been suggested as etiologies, but the exact mechanism remains unknown.² The typical echocardiographic findings are hyperkinesis of the basal part of the midventricular segment and hypokinesis or akinesis of the apical segment, which does not match the perfusion pattern of the coronary arteries. TCM is known to be associated with electrocardiographic abnormalities such as ST elevation, prolonged QTc, and inverted T waves, and sometimes causes potentially fatal arrhythmias such as torsades de pointes.^{2,3} The modified guidelines of the Mayo Clinic include cerebrovascular diseases in the diagnosis of TCM⁴ and multiple reports have examined TCM related to subarachnoid hemorrhage (SAH).⁵⁻¹² The present report proposes further findings, particularly regarding the different timings for normalization of electrocardiograms and echocardiograms in TCM related to SAH.

METHODS

Between January 2007 and November 2015, a total of 450 patients with aneurysmal SAH (including dissecting aneurysms) had been admitted to our hospital. Ten of these cases were confirmed as presenting with TCM in the clinical records. All patients

Key words

- Electrocardiogram
- Subarachnoid hemorrhage
- Takotsubo cardiomyopathy

Abbreviations and Acronyms

ECG: Electrocardiography, electrocardiographic
NPE: Neurogenic pulmonary edema
SAH: Subarachnoid hemorrhage
TCM: Takotsubo cardiomyopathy
TTE: Transthoracic echocardiography, echocardiographic
WFNS: World Federation of Neurosurgical Societies

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Citation: *World Neurosurg.* (2017) 100:467-473.
<http://dx.doi.org/10.1016/j.wneu.2017.01.051>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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Table 1. Characteristics of the Patients with Takotsubo Cardiomyopathy

Patient Number	Age	Sex	Aneurysm	WFNS Grade	Fisher Group	Treatment	mRS	NPE	ECG Findings	TTE Findings
1	90	F	Rt.IC-PC	2	3	Conservative	3	+	inverted T QTc prolongation ST elevation	EF57%
2	65	F	Rt.IC-PC	4	4	Clipping	2	–	inverted T QTc prolongation ST elevation	EF48%
3	63	F	Acom	5	4	Coiling	2	+	inverted T QTc prolongation ST elevation	EF44%
4	67	F	BA top	2	3	Clipping	2	+	ST elevation	EF32% thrombus
5	64	F	Rt.VA dissection	2	2	Coiling (internal trapping)	0	–	inverted T QTc prolongation ST elevation AF	EF44%
6	75	F	Acom	5	4	Clipping	5	+	inverted T QTc prolongation	EF35%
7	81	F	Lt.PCA dissection	4	3	Coiling (internal trapping)	4	+	ST depression ST elevation and flattened T wave	EF47%
8	71	F	Lt.IC-PC	5	4	Conservative	6	+	Inverted T inverted P QTc prolongation Vf (day 1)	EF 29%
9	77	F	Rt.IC-PC	4	3	Clipping	2	+	Inverted T QTc prolongation ST elevation ST depression	EF 45%
10	40	F	Rt.IC-PC	4	3	Clipping	0	+	Flattened T wave ST elevation	EF 46%

IC-PC, internal carotid artery-posterior communicating artery; Acom, anterior communicating artery; VA, vertebral artery; BA, basilar artery; NPE, neurogenic pulmonary edema; Vf, ventricular fibrillation; AF, atrial flutter; EF, ejection fraction.

underwent electrocardiography (ECG) and chest roentgenogram on admission. Patients who presented with clinical symptoms of heart failure, such as dyspnea, palpitation, stridor, pink blood-tinged mucus, and coarse crackles on auscultation, also underwent transthoracic echocardiography (TTE). Patients with no medical justification for treating aneurysm did not undergo TTE. We selected the 10 patients who met the following criteria: 1) TTE findings with hyperkinesis of the basal part of the midventricular segment and hypokinesis or akinesis of the apical part, which does not match the territory of the coronary arteries. So-called inverted takotsubo cardiomyopathy associated with hypokinesis or akinesis of the basal contraction and apical sparing was also included. 2) Improvement of abnormal findings of TTE on subsequent studies. After hospitalization, patients were monitored in the Stroke Care Unit for at least the 2-week cerebral vasospasm period. Until surgery, patients were sedated with propofol to prevent rebleeding. We maintained normovolemia after surgical treatment. For patients with symptomatic cerebral vasospasm,

dobutamine was administered only if cardiac function had improved. We examined the following items: age, sex, location of aneurysm, World Federation of Neurosurgical Societies (WFNS) grading scale, Hunt & Kosnik grading, Fisher classification, presence or absence of neurogenic pulmonary edema (NPE), type of surgical treatment, modified Rankin scale score, abnormal findings on ECG and their duration, and abnormal findings of TTE and their duration. TTE was not performed either every day or on specific days. The schedule of TTE varied according to the condition of the patient and plans for other examinations.

RESULTS

Participants and Characteristics

TCM was detected in 10 of the 450 patients (2.2%). The clinical features of these patients are presented in **Table 1**. All 10 patients with TCM were women and mean age at diagnosis was 69.3 years (range, 40–90 years). Nine of the 10 women developed TCM after

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