INTRODUCTION

Acute chest pain and transient apical hypokinesis with hyperkinesis in the basal area, without detectable coronary lesions, was originally called "transient left ventricular apical ballooning (takotsubo cardiomyopathy)." Patients with this syndrome demonstrate electrocardiography (ECG) changes similar to those seen in acute myocardial infarction with increased levels of serum cardiac enzymes. However, ventricular function normalizes within several weeks. A number of patients have presented with this syndrome in Japan. Both emotional and somatic stress are considered to be significant risk factors. Here, we report two cases of takotsubo cardiomyopathy induced by emotional stress caused by the Central Niigata Prefecture Earthquake in 2004.

Two patients presented with transient left ventricular apical ballooning (takotsubo cardiomyopathy) induced by emotional stress caused by the Central Niigata Prefecture Earthquake in 2004. These patients complained of chest pain immediately after the earthquake. In patient 1, electrocardiography (ECG) showed slight ST elevation in leads II, III, and aVF, and 1 mm ST depression in lead aVR. Serial ECG revealed inverted giant T waves in leads II, III, and aVF, and inverted T waves in leads I, aVL, and aVR 13 days after the earthquake occurred. Patient 2 also complained of chest pain right after the earthquake, but consulted a doctor 15 days after the earthquake occurred. ECG showed inverted giant T wave in lead II, III, and aVF, and inverted T waves in leads I, aVL, and aVR. Transthoracic echocardiography showed hypokinesis of the apical area of the left ventricle with normokinesis in the basal area in both patients. Coronary angiography showed no stenotic segments and coronary spasms were not induced by provocative testing. Serial cardiac radionuclide single photon emission computed tomography of myocardial functional sympathetic innervation using iodine-123-metaiodobenzyl-guanidine (MIBG) and thallium-201 (201Tl) showed an MIBG uptake defect and increased wash-out in the apical area, but only mild decrease of apical 201Tl uptake. Due to strong emotional stress, earthquakes may induce transient left ventricular apical ballooning (takotsubo cardiomyopathy).

Key Words
Cardiomyopathies, other (takotsubo, transient left ventricular apical ballooning)
Stress (earthquakes, emotional)
Electrocardiography

Abstract

Two patients presented with transient left ventricular apical ballooning (takotsubo cardiomyopathy) induced by emotional stress caused by the Central Niigata Prefecture Earthquake in 2004. These patients complained of chest pain immediately after the earthquake. In patient 1, electrocardiography (ECG) showed slight ST elevation in leads II, III, and aVF, and 1 mm ST depression in lead aVR. Serial ECG revealed inverted giant T waves in leads II, III, and aVF, and inverted T waves in leads I, aVL, and aVR 13 days after the earthquake occurred. Patient 2 also complained of chest pain right after the earthquake, but consulted a doctor 15 days after the earthquake occurred. ECG showed inverted giant T wave in lead II, III, and aVF, and inverted T waves in leads I, aVL, and aVR. Transthoracic echocardiography showed hypokinesis of the apical area of the left ventricle with normokinesis in the basal area in both patients. Coronary angiography showed no stenotic segments and coronary spasms were not induced by provocative testing. Serial cardiac radionuclide single photon emission computed tomography of myocardial functional sympathetic innervation using iodine-123-metaiodobenzyl-guanidine (MIBG) and thallium-201 (201Tl) showed an MIBG uptake defect and increased wash-out in the apical area, but only mild decrease of apical 201Tl uptake. Due to strong emotional stress, earthquakes may induce transient left ventricular apical ballooning (takotsubo cardiomyopathy).

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triggering factors in this cardiac syndrome. We treated two patients with this syndrome induced by emotional stress due to the Central Niigata Prefecture Earthquake in October 2004.

CASES

Patient 1
A 67-year-old woman had been well until she was admitted to the emergency room of our hospital with chest pain immediately after the main shock of the Central Niigata Prefecture Earthquake in October 2004. ECG showed slight ST elevation in leads Ⅱ to Ⅵ and ST-depression in lead Ⅰ immediately upon admission after the main shock of the earthquake. T waves were inverted in leads Ⅰ, Ⅲ, Ⅱ, aVL, aVR, and Ⅴ₁ to Ⅴ₆ at the time of hospitalization (B) and T wave inversions persisted in leads Ⅰ to Ⅴ₁ for more than 6 months (C).

Patient 2
A 78-year-old woman with hypertension complained of chest pain immediately after the earthquake. However, she was only hospitalized 15 days after the earthquake because her house was severely damaged and she evacuated to her daughter’s house. Previous ECG had found no abnormalities.

Fig. 1 Patient 1. Electrocardiographic findings showing the time course of T wave changes
A: Electrocardiography shows slight ST elevation in leads Ⅰ to Ⅴ₆ and ST-depression in lead Ⅰ immediately upon admission after the main shock of the earthquake.
B, C: T waves were inverted in leads Ⅰ, Ⅲ, aVL, aVR, and Ⅴ₁ to Ⅴ₆ at the time of hospitalization (B) and T wave inversions persisted in leads Ⅰ to Ⅴ₁ for more than 6 months (C).
However, the first ECG obtained at our hospital showed inverted giant T waves in leads $\text{I} \text{ to } \text{V}_6$ and inverted T waves in leads $\text{V}_1$, $\text{V}_2$ and $\text{V}_3$ (Fig. 4 · A). Routine laboratory studies were normal but TTE demonstrated hypokinesia in the apical area of the left ventricle with normokinesia in the basal area. She was admitted to our hospital. Coronary angiography undertaken the next day showed no stenotic segments and provocation testing did not induce coronary spasm. Left ventriculography revealed slight hypokinesis in the apical area. MIBG imaging showed significant uptake defects.
and increased wash-out in the apex, septum, anterior, and lateral wall, whereas ²⁰¹TI uptake was only mildly decreased (Fig. 3 - B - a). Left ventricular contraction normalized several days after admission. ECG findings after 6 months were almost normalized (Fig. 4 - B). In contrast, MIBG uptake defect in the apical region persisted for several months (Fig. 3 - B - b).

**DISCUSSION**

A severe earthquake of magnitude 6.8 occurred in the central area of Niigata Prefecture on October 23, 2004. Three main strong earthquakes of seismic intensity over 6 occurred on that day followed by multiple aftershocks. More than 4,500 people were injured and essential services were disrupted. In such a situation, the emotional stress experienced by inhabitants must have been very great. Cardiovascular events, such as myocardial infarction, could be triggered by the accumulated stress of an earthquake.⁵,⁶ Our two patients with transient left ventricular apical ballooning (takotsubo cardiomyopathy) presented with symptoms at our hospital right after the earthquake.

Transient left ventricular apical ballooning (takotsubo cardiomyopathy) is a syndrome characterized by acute onset of ST-segment elevation and subsequent T-wave inversion but with normal coronary angiography findings. TTE and/or left ventriculography reveals apical dilation and akinesis, and basal hypokinesis (or occasionally normokinesis) which gives the heart the characteristic shape (takotsubo in Japanese). Left ventricular function normalizes within several weeks.¹-³

In our patients, ST-T segment changes and inverted giant T waves were present in leads V₁, V₁₂, and aVL to V₆. After admission, left ventriculography had already improved in both patients, but TTE on admission revealed hypokinesis of the apical region with normokinesis in the basal area without evidence of atherosclerosis of the coronary arteries. These findings support the diagnosis of transient left ventricular apical ballooning (takotsubo cardiomyopathy).

Although the mechanism responsible for transient left ventricular apical ballooning remains unclear, various systemic disorders including cerebrovascular accident,⁷ epileptic attacks, exacerbation of bronchial asthma, hypoglycemia in the setting of anorexia nervosa,⁸ pheochromocytoma,⁹ and emotional/physical stress⁵ have been reported to trigger development of transient left ventricular apical ballooning. Moreover, a case of crush syndrome with inverted giant T waves and reversible

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**Fig. 4** Patient 2. Electrocardiographic findings on admission (A) and more than 6 months after the earthquake and aftershocks (B).

**A:** Electrocardiography revealing T-wave inversions in leads V₁, V₁₂, aVL, and V₆ to V₆.

**B:** T-wave changes improved after 6 months.
left ventricular dysfunction, was reported in a patient who was rescued after being buried under his house for 20 hr during the earthquake in the Kansai area.10 Our patients experienced great suffering and mental stress after the earthquakes of seismic intensity over 5. They also suffered transient left ventricular apical ballooning triggered by the earthquake.

In the present cases, MIBG images showed apical deficit and an increase in the MIBG wash-out in that region. This defect and increase in the washout of MIBG persisted for several months after the onset, indicating that emotional stress induced disturbance of both sympathetic innervation and sympathetic denervation. These results are compatible with the findings observed with transient left ventricular apical ballooning.5,10

Patients with transient left ventricular apical ballooning may complain of chest pain but usually it is relatively mild compared to that of acute myocardial infarction. Echocardiography and left ventriculography were not performed in the early stage in these patients. The typical takotsubo shape of the left ventricle was not confirmed but the typical changes of the ECG and nuclear imaging suggested the transient left ventricular apical ballooning was most likely triggered by the earthquake in these patients.

CONCLUSIONS

Determination in hospital functions is very likely immediately after an earthquake, but physicians must assess each patient’s condition and identify the disease. Cases of transient left ventricular apical ballooning are likely after an earthquake.

References


