Takotsubo cardiomyopathy with marked ST-segment elevation and electrical alternans complicated with hyperglycemic hyperosmolar state

Takotsubo Cardiomyopathy With Marked ST-Segment Elevation and Electrical Alternans Complicated With Hyperglycemic Hyperosmolar State

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SUMMARY

This is the first report of a case of Takotsubo cardiomyopathy with a hyperglycemic hyperosmolar state (HHS). This case presented with marked ST-segment elevation and electrical alternans, uncommon findings in Takotsubo cardiomyopathy. We believe that hyperosmolarity-induced myocardial dehydration and consequent increase in intracellular calcium concentration may be the mechanism of Takotsubo cardiomyopathy and electrical alternans in HHS. (Int Heart J 2008; 49: 629-635)

Key words: Takotsubo cardiomyopathy, Electrical alternans, Hyperglycemic hyperosmolar state

THERE have been several reports of cardiac complications with a hyperglycemic hyperosmolar state (HHS), such as acute myocardial infarction[1,2] and heart failure.[3] However, there are no reports of Takotsubo cardiomyopathy with HHS. We report a case of Takotsubo cardiomyopathy with HHS exhibiting marked ST-segment elevation and electrical alternans. The mechanism of these rare findings is discussed.

CASE REPORT

An 81-year-old woman was admitted to our hospital because of coma on September 2007. She had undergone clipping of a cerebral aneurysm due to subarachnoid hemorrhage at 53 years-old. She was diagnosed with diabetes mellitus at 61 years-old and had used insulin since she was 78. Before admission, she was febrile and could not eat for a few days. On admission, her blood pressure was 120/80 mmHg and her pulse rate was 110 bpm. Physical findings revealed dry tongue and decreased turgor of skin indicating dehydration. Chest X-rays showed

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Table. Laboratory Data on Admission

Hematologic laboratory values	
White blood cell count (/mm^3)	16,000
Red blood cell count (/mm^3)	372×10^4
Hemoglobin (g/dL)	12.1
Hematocrit (%)	36.7
Platelet count (/mm^3)	8.7×10^4
Blood chemical values	
Creatinine (mg/dL)	0.7
Urea nitrogen (mg/dL)	59
Na (mEq/L)	186
K (mEq/L)	3.4
Cl (mEq/L)	143
Total protein (g/dL)	4.8
Aspartate aminotransferase (IU/L)	112
Alanine aminotransferase (IU/L)	55
Lactate dehydrogenase (IU/L)	552
Creatine kinase (IU/L)	679
Glucose (mg/dL)	421
Hemoglobin A1C (%)	8.2
Osmolality (mosmol/L)	423
Arterial blood gas levels	
pH	7.468
Carbon dioxide tension (mmHg)	47.5
Oxygen tension (mmHg)	88.1
Bicarbonate (mEq/L)	33.6

mild cardiomegaly and consolidation in the right upper lobe. A brain CT showed no cerebrovascular lesion. Laboratory data indicated marked hypernatremia (serum Na was 186 mEq/L), hyperglycemia (plasma glucose was 421 mg/dL), azotemia (serum urea was 59 mg/dL), and hyperosmolality (serum osmolality was 423 mosmol/L). Arterial blood gas sampling revealed no metabolic acidosis (Table). We made a diagnosis of pneumonia and a hyperglycemic hyperosmolar state, and saline infusion and insulin infusion were started. An electrocardiogram showed ST-segment elevation in leads V2, V3, and V4 and T wave inversion in leads I, II, III, aVF, and V1~6 (Figure 1). Echocardiography showed severe left ventricular dysfunction in the midventricle and apex with preserved basal function and no pericardial effusion. Left ventricular end-diastolic dimension was 45 mm and the left ventricular ejection fraction was 31% by the Simpson method. Mitral inflow velocity presented a restrictive filling pattern and the deceleration time was 121 ms. Mild aortic regurgitation was present but mitral regurgitation was not. We suspected Takotsubo cardiomyopathy based on the echocardiogram findings, but acute myocardial infarction could not be excluded. Coronary angiography was not performed because we thought that contrast agent might be

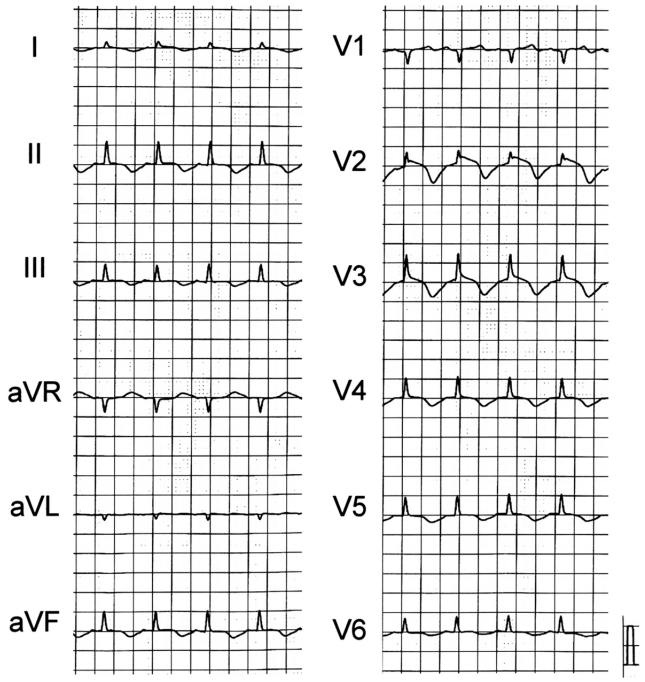

Figure 1. Electrocardiogram on admission.

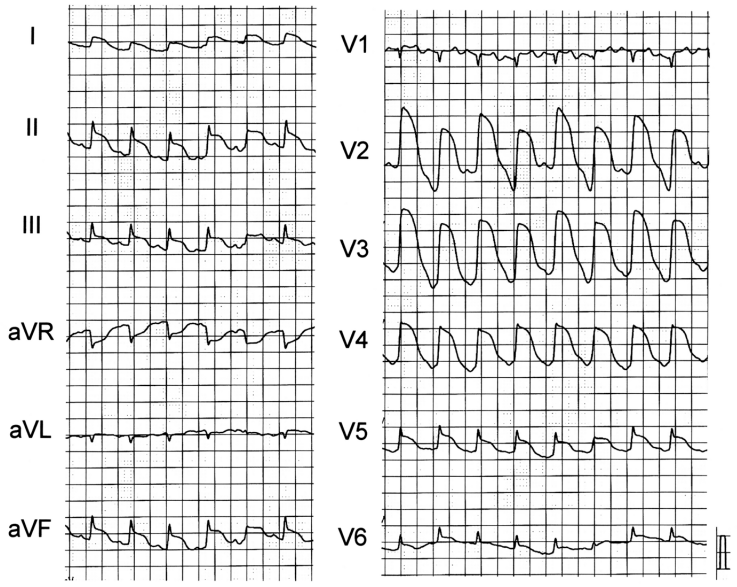

Figure 2. Electrocardiogram at 14 hours from admission.

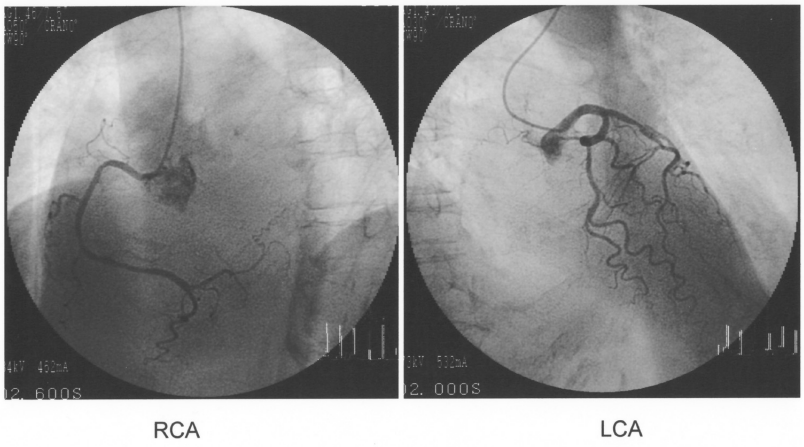

Figure 3. Coronary angiography. RCA indicates right coronary artery and LCA, left coronary artery.

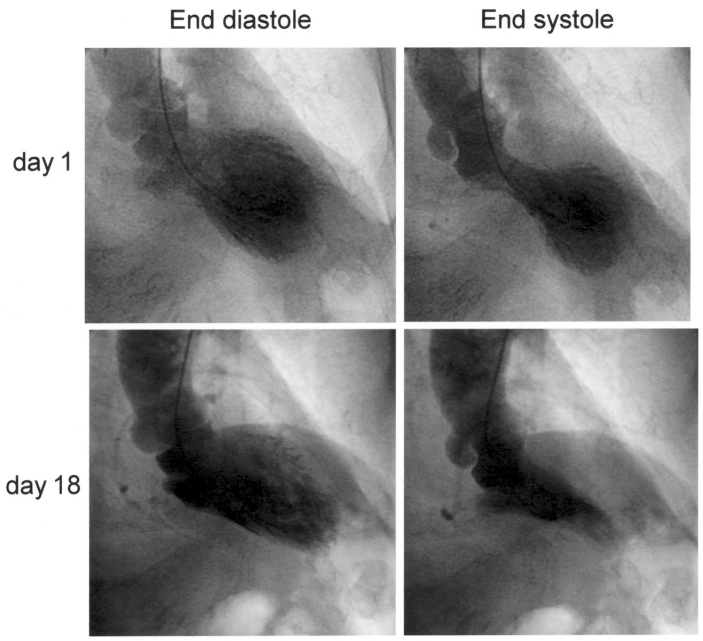

Figure 4. Left ventriculogram on day 1 and day 18.

harmful due to her hyperosmolar state. At ten hours from admission, an electrocardiogram showed marked ST-segment elevation, following which electrical alternans appeared in leads V2 and 3 (Figure 2). At this time, serum Na was 172 mEq/L, plasma glucose 356 mg/dL, and serum osmolality 386 mosmol/L. We

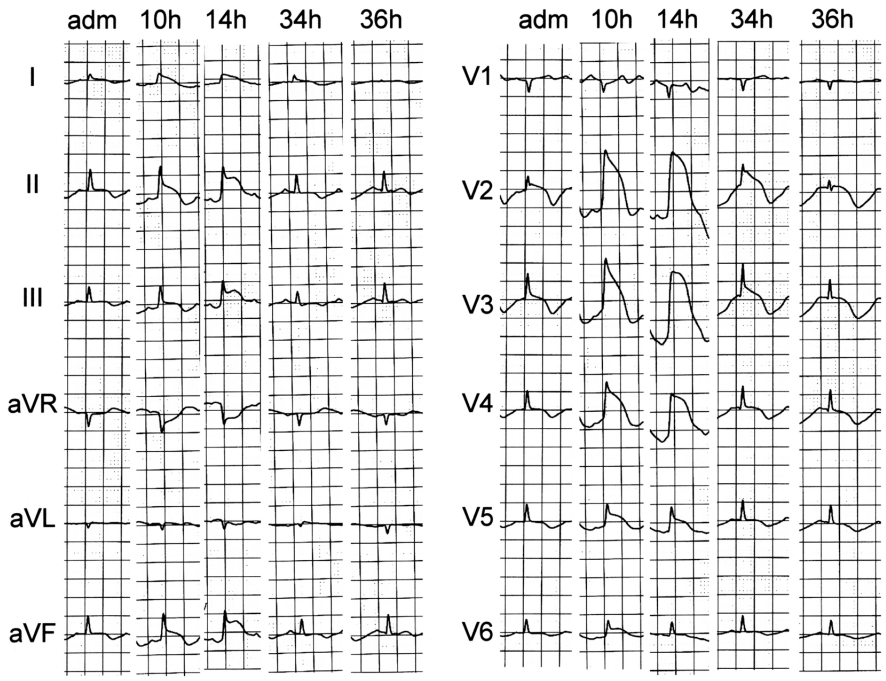

Figure 5. Serial changes in electrocardiogram. adm indicates on admission.

suspected acute myocardial infarction and emergent coronary angiography was performed. However, coronary angiography revealed no epicardial artery occlusion (Figure 3). Left ventriculography showed dyskinesis in the mid-ventricle and apex with preserved basal function indicating Takotsubo cardiomyopathy (Figure 4). Left ventricular pressure recordings showed no intraventricular pressure gradient. Marked ST-segment elevation persisted for about 24 hours. Thereafter, the ST-segment elevation gradually weakened and had completely disappeared at 36 hours from admission. A subsequent electrocardiogram showed T wave inversion but no abnormal Q waves (Figure 5). At this time, serum Na was 156 mEq/L, plasma glucose 268 mg/dL, and serum osmolality 346 mosmol/L. Echocardiography revealed the left ventricular ejection fraction was 36% on the second day and 58% on the 10th day. The peak value of creatine kinase MB was 89 IU/L. On the third day, the serum concentration of adrenaline was 102 pg/mL (normal <100), noradrenaline 791 pg/mL (normal 100-450), and dopamine 189 pg/mL (normal < 20). A left ventriculogram on the 18th day from admission showed normal left ventricular function (Figure 4).

DISCUSSION

Takotsubo cardiomyopathy is a novel cardiac syndrome characterized by transient left ventricular dysfunction with chest pain, electrocardiographic changes, and minimal myocardial enzymatic release mimicking acute myocardial infarction.[4-6] Exaggerated sympathetic stimulation may be the cause of this syndrome.[4-6] Takotsubo cardiomyopathy has been described in clinical states of catecholamine excess such as emotional stress,[4-6] noncardiac surgery,[4,5] subarachnoid hemorrhage,[7] and pheochromocytoma.[8]

There have been several reports of cardiac complications with a hyperglycemic hyperosmolar state (HHS), such as acute myocardial infarction[1,2] and heart failure.[3] However, there have been no reports of Takotsubo cardiomyopathy with HHS.

The effects of hyperosmolarity on myocardium are myocardial dehydration and a consequent increase in intracellular calcium concentration,[9,10] inhibition of Na^+-K^+ pump activity,[11] and intracellular alkalosis due to activation of the sarcolemmal Na^+-H^+ exchanger.[12] On the other hand, the possible mechanism of Takotsubo cardiomyopathy is catecholamine-mediated myocardial stunning. Catecholamines induce myocardial injury through cyclic AMP-mediated calcium overload.[13] In addition, cathecholamines are a potential source of oxygen-derived free radicals which interfere with sodium and calcium transporters and induce intracellular calcium overload.[14] Based on these findings, we propose that a hyperosmolarity-induced increase in intracellular calcium concentration may be the underlying mechanism of Takotsubo cardiomyopathy with HHS.

This case presented with marked ST-segment elevation and electrical alternans, which to the best of our knowledge are uncommon findings in Takotsubo cardiomyopathy. Electrical alternans seen on the ST segment was frequently observed in severe myocardial ischemia and is a predictor of life-threatening ventricular arrhythmia.[15] A proposed mechanism of electrical alternans is delayed intracellular Ca^{2+} cycling mediated by sarcoplasmic reticulum and ryanodine receptors.[16] We believe that a hyperosmolarity-induced increase in intracellular calcium concentration may have overcome the delayed intracellular Ca^{2+} cycling in the myocardium and induced electrical alternans in this patient.

In HHS, ST-segment elevation on an electrocardiogram usually suggests acute myocardial infarction. However, our case indicates Takotsubo cardiomyopathy can occur in HHS. Further studies are necessary to clarify the relationship between Takotsubo cardiomyopathy and HHS.

Conclusion: We report a case of Takotsubo cardiomyopathy with marked ST-segment elevation and electrical alternans complicated with HHS. This case indicates that cardiac complications in HHS include not only myocardial infarction but also Takotsubo cardiomyopathy.

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