# Clinical Critical Care

E-ISSN 2774-0048

VOLUME 31 NUMBER 1

JANUARY-DECEMBER 2023

Clinical Critical Care
eISSN 2774-0048

Clinical Critical Care
Volume 31, Article ID e0013, 7 pages
https://doi.org/10.54205/ccc.v31.262640

CASE REPORT

# Diabetic ketoacidosis induced Takotsubo cardiomyopathy: A case report

Napassorn Teeratakulpisarn, Saranthorn Purngcharoenkul, Surat Tongyoo

Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, 10700

OPEN ACCESS
**Citation:**
Teeratakulpisarn N, Purngcharoenkul S, Tongyoo S. Diabetic ketoacidosis induced Takotsubo cardiomyopathy: A case report. Clin Crit Care 2023; 31: e0013.

**Received:** April 25, 2023
**Revised:** June 18, 2023
**Accepted:** Aug 1, 2023



**Data Availability Statement:**
The data and code were available upon reasonable request (Napassorn Teeratakulpisarn, email address: napastee@gmail.com)

**Funding:**
This was an unfunded study.

**Competing interests:**
No potential conflict of interest relevant to this article was reported.

**Corresponding author:**
Napassorn Teeratakulpisarn
Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, 10700
Tel: (+65) 2-419-9465
E-mail: napastee@gmail.com

## ABSTRACT:

Takotsubo cardiomyopathy (TC) is a syndrome of transient regional wall motion abnormalities of the left ventricle causing an apical ballooning pattern. This condition can be triggered by intense emotional or physical stress. In the past, many case reports showed cases of diabetic ketoacidosis induced Takotsubo cardiomyopathy who presented with initial ST segment elevation ECG at the present to the hospital simultaneously with the ongoing stress. In this paper, we report a case of Takotsubo cardiomyopathy whose ST segment changed 2 days after the resolution of diabetic ketoacidosis.

**Keywords:** Takotsubo cardiomyopathy, Diabetic ketoacidosis

## INTRODUCTION

Takotsubo cardiomyopathy (TC) is a syndrome characterized by transient regional wall motion abnormalities of the left ventricle. It is typically characterized by apical hypokinesia, akinesia, or dyskinesia, with most cases exhibiting basal hyperkinesia, resulting in a left ventricular apical ballooning pattern. [1] Strong mental and/or physical stress has been observed to potentially cause Takotsubo cardiomyopathy, also known as stress cardiomyopathy or broken heart syndrome. [1]

Among many potential triggers, Diabetic ketoacidosis (DKA) is one catastrophic medical condition that can cause Takotsubo cardiomyopathy. Frequently, the clinical presentation of heart failure and electrocardiogram (ECG) changes occurs simultaneously with the ongoing stress of diabetic ketoacidosis and improves within 3 days after the resolution of the acidosis [2-9]. However, in this paper we report a case of Takotsubo cardiomyopathy that presented 2 days after the resolution of diabetic ketoacidosis.

## CASE REPORT

A 44 year-old woman with a past history of rheumatoid arthritis, who was lost to follow-up for 5 years, presented with fever and periumbilical abdominal pain for 1 week. The patient then developed a shortness of breath, which brought her to the emergency department. Upon arrival, her vital signs were body temperature of 36.6°C, heart rate of 124 beats per minute, blood pressure of 133/96 mmHg, and respiratory rate of 24 breaths per minute. Her heart sounds were normal, without murmurs. Lung sounds were clear and equal on both sides. Abdominal examination revealed a decrease in bowel sound but no guarding or tenderness.

The initial laboratory tests revealed leukocytosis with neutrophil predominance. Blood glucose was 791 mg/dl, beta-hydroxybutyrate > 8 mmol/L, and the electrolyte levels were as follows: sodium 125 mmol/L, potassium 6.1 mmol/L, chloride

92 mmol/L, $HCO_3$ 7 mmol/L, and anion gap 26 mmol/L. The BUN level was 22.7 mg/dL, creatinine was 0.8 mg/dL, and lactate was 3.5 mmol/l. Urine analysis showed significant glucosuria and ketonuria. Venous blood gas showed severe metabolic acidosis (pH 6.90, $PaCO_2$ 15.5 mmHg, $PaO_2$ 60 mmHg, $HCO_3$ 3 mmol/l). Acute abdominal series plain films were unremarkable (Figure1). The initial electrocardiogram (ECG) showed diffuse ST-depression at leads $V_2$-$V_6$, I, AVL, II, III, and AVF (Figure 2).

The patient was diagnosed with diabetic ketoacidosis, which was precipitated by an infection of unknown primary source. She was transferred to the intensive care unit (ICU) for further management. During her ICU admission, the patient was treated with a bolus dose of 0.9% NaCl solution, an empirical intravenous antibiotic, intravenous sodium bicarbonate, and a continuous intravenous insulin drip with an initial dose of 0.1 unit/kg/hr. Her blood sugar gradually decreased, and metabolic acidosis improved within 24 hours. The ECG at the time of ICU arrival is shown in Figure 3. There was no abnormal ST depression or elevation detected.

On day 2 of admission, the patient complained of a sudden onset of shortness of breath and chest tightness. A 12 leads ECG revealed diffuse ST-elevation at leads II, III, AVF, I, AVL, and $V_4$-$V_6$, with ST-depression at $V_1$ and AVR (Figure 4). Her high sensitivity troponin-T level was 192 ng/l (<14 ng/L). A chest X-ray presented bilateral pulmonary congestion without consolidation (Figure 5). Transthoracic echocardiography was performed. The results revealed impaired left ventricular ejection fraction with anterior and inferior wall hypokinesia, no mitral regurgitation, no ventricular septal rupture, no free wall rupture, and no pericardial effusion (Figure 6). The diagnosis of acute ST elevation myocardial infarction (STEMI) with congestive heart failure was made. The patient was immediately transported to the catheterization room, and the coronary angiography with left ventriculography was performed without immediate complications (figure 7,8,9).The coronary angiography showed no significant coronary artery stenosis. However, there was a significant elevation of left ventricular end diastolic pressure (28 mmHg). The left ventriculogram revealed midventricular systolic dysfunction consistent with a midventricular variant of stress induced cardiomyopathy.

**KEY MESSAGES:**

- Takotsubo cardiomyopathy is a syndrome of transient regional wall motion abnormalities of the left ventricle causing an apical ballooning pattern.
- Many intense emotional or physical stresses can trigger Takotsubo cardiomyopathy, including diabetic ketoacidosis. This is not a rare condition and can be presented in different clinical settings depending on age, sex, type of diabetes mellitus, and onset of cardiomyopathy. Early recognition and prompt investigation are key to making the diagnosis and giving appropriate treatment.

According to echocardiography, cardiac enzyme, and coronary angiography results, Takotsubo cardiomyopathy was diagnosed. After conservative treatment with negative fluid balance, her dyspnea improved, and she was transferred to the general ward, where her symptoms continued to improve over the course of a few days. The patient was discharged with subcutaneous premix insulin and prescribed medication for her underlying Rheumatoid arthritis.

## DISCUSSION

Takotsubo cardiomyopathy was first described in Japan in 1990. The name 'Takotsubo' refers to the apical ballooning shape of the left ventricle that looks like an octopus trap used in Japan. This condition was initially considered a rare disease; however, due to increased awareness, the current prevalence is increasing and is now estimated to affect approximately 2% of the population. [1]

The exact pathophysiology of Takotsubo cardiomyopathy is still unknown. The proposed mechanism involves a combination of sympathetic activation and elevation of

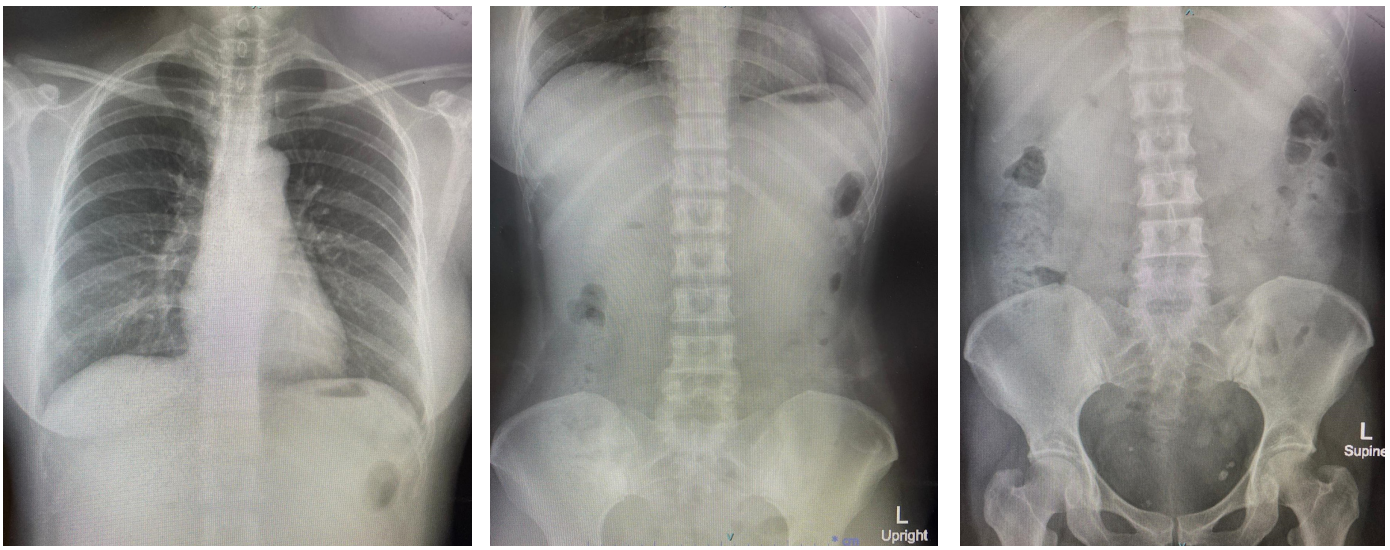


**Figure 1.** Acute abdomen series plain film shows no evidence of pulmonary infiltration, abnormal bowel gas pattern, or signs of hollow viscus organ perforation.

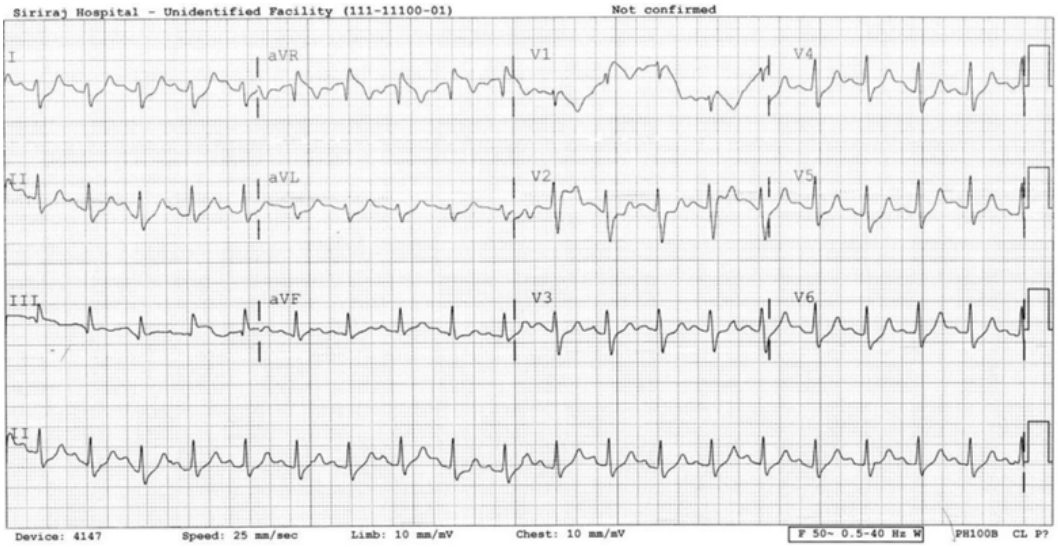


**Figure 2.** Initial ECG-12 leads at emergency department shows sinus rhythm without significant ST abnormality.

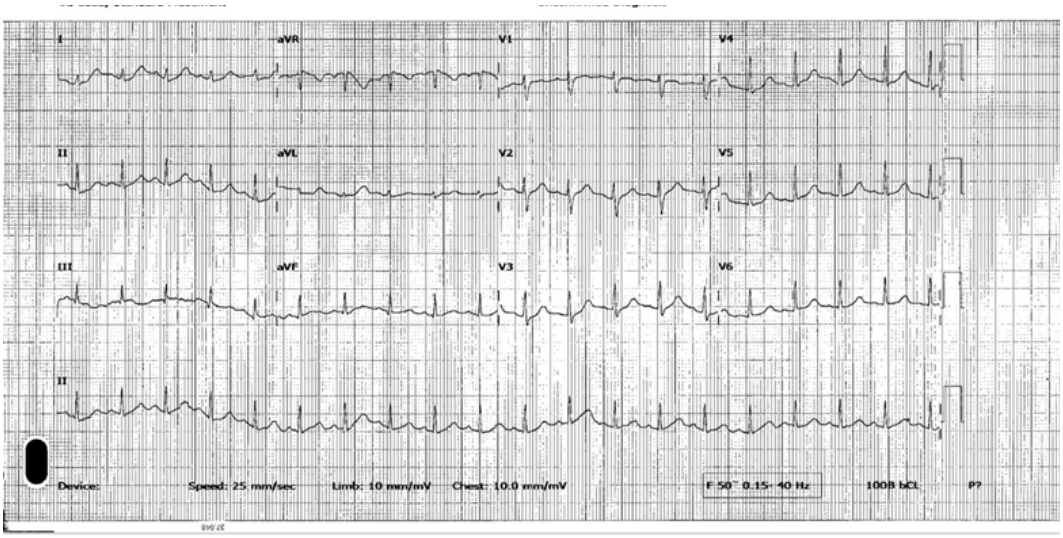


**Figure 3.** ECG-12 leads at intensive care unit.

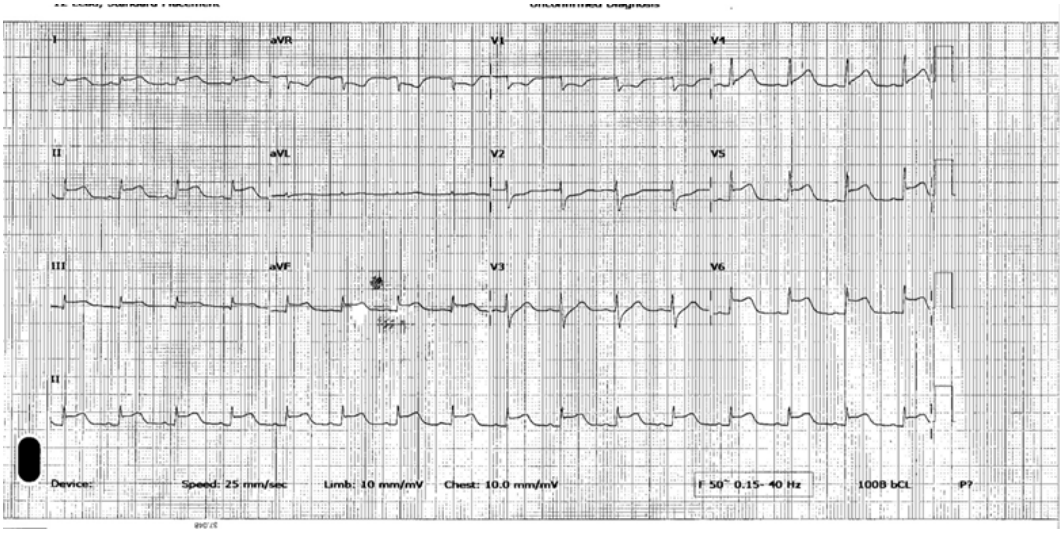


**Figure 4.** ECG-12 leads at onset of chest tightness with ST elevation at lead II, III, aVF, I, V5, andV6.

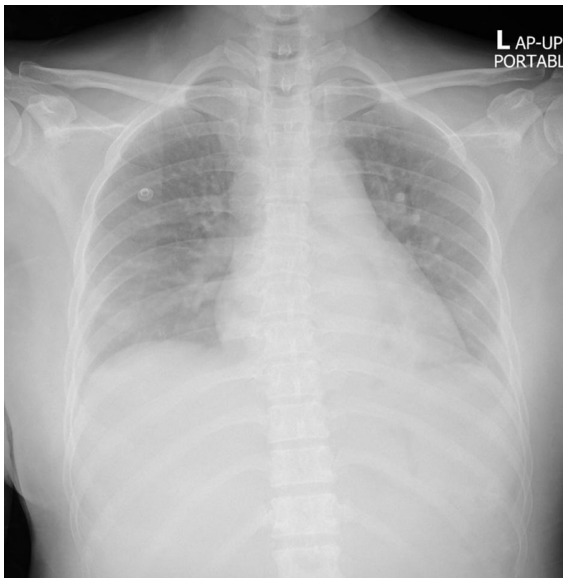


**Figure 5.** Chest X-ray at onset of chest tightness shows bilateral pulmonary congestion.

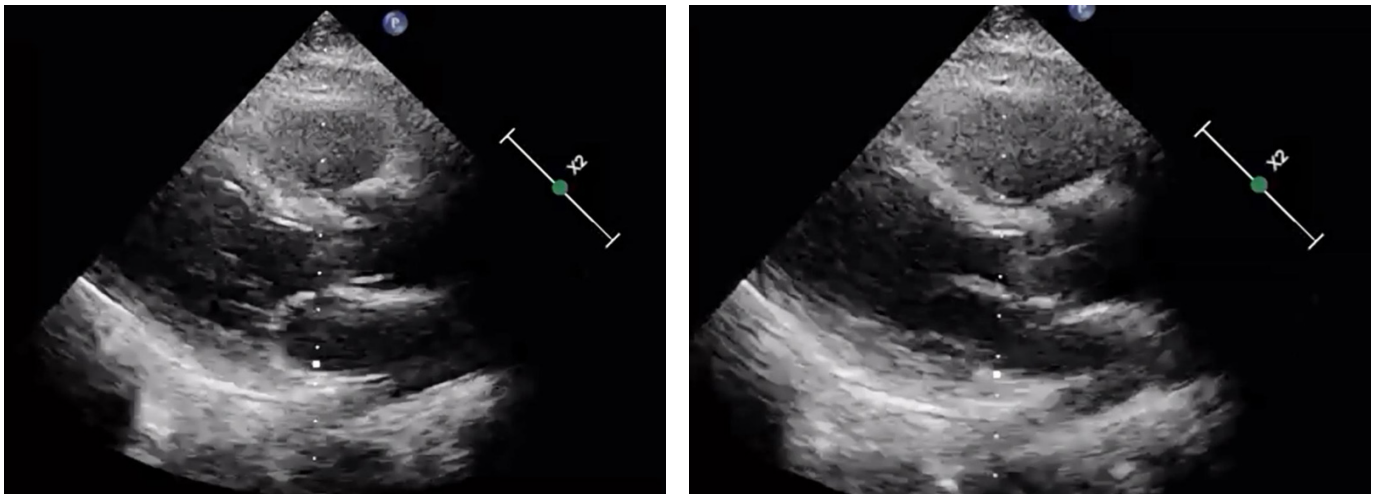


**Figure 6.** Transthoracic echocardiogram; parasternal long axis view showed an inferior wall hypokinesia with impaired left ventricular systolic function.

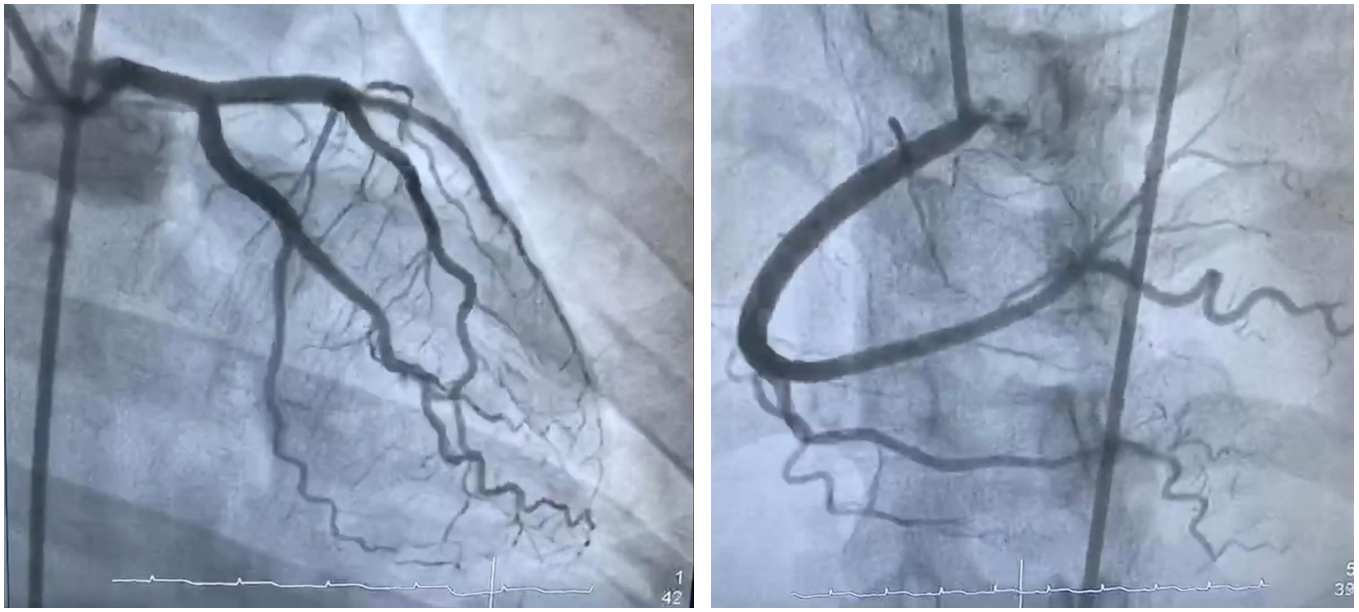

**Figure 7.** Coronary angiography showed no significant coronary artery stenosis, however there was an elevation of left ventricular end diastolic pressure (28 mmHg).

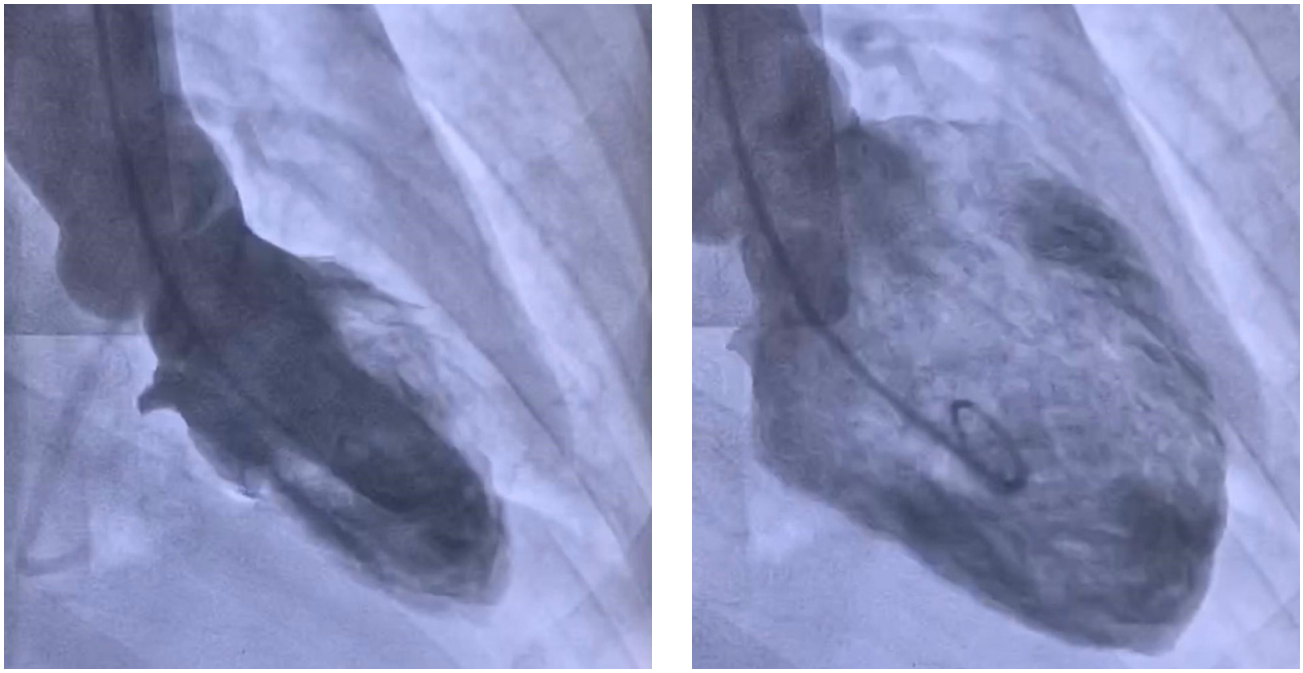

**Figure 8.** Left ventriculogram showed midventricular systolic dysfunction compatible with midventricular variant of stress induced cardiomyopathy without abnormal finding in diastolic phase.

circulating catecholamine levels, which leads to coronary dysfunction, increased left ventricular afterload, and direct catecholaminergic stimulation through altered beta-adrenergic receptor signaling. The overall result is myocardial dysfunction, particularly affecting the apical and midventricular segments. [10]

Takotsubo cardiomyopathy is typically characterized by chest pain at rest, which resembles typical angina. [11] Other clinical features include shortness of breath resulting from pulmonary edema, while dizziness and syncope are less common. A few of the patients might develop arrhythmias, cardiogenic shock, and sudden cardiac arrest. [11-12]

According to the widely used diagnostic criteria for Takotsubo Syndrome provided by the Heart Failure Association of the European Society of Cardiology, newly developed and reversible electrocardiography abnormalities during the acute phase (usually within 3 months) should be considered ECG features of Takotsubo cardiomyopathy. These abnormalities may include ST-segment elevation or depression, left bundle branch block, T-wave inversion, and/or QTc prolongation. However, the most common ECG finding pattern is ST segment elevation. [12] Based on our literature review, cases documenting diabetic ketoacidosis associated with Takotsubo cardiomyopathy mostly presented with ST segment elevation in leads II, III, aVF, and lateral leads.

The most noticeable difference between Takotsubo cardiomyopathy and acute myocardial infarction is the absence of culprit atherosclerotic coronary angiographic findings. In comparison to patients with ST elevation myocardial infarction, patients with Takotsubo cardiomyopathy typically exhibit TIMI 3 flow in all major epicardial arteries, a lower mean number of plaques per patient, and a smaller distribution of the plaques. [13] So the coronary artery angiogram could be performed for a definite diagnosis of Takotsubo cardiomyopathy.

From a recent case report of diabetic ketoacidosis-associated Takotsubo cardiomyopathy, most cases presented with documented poor left ventricular ejection fraction, along with apical hypo/akinesia and/or ST segment elevation upon arrival at medical treatment. [2-9] There were only two cases, similar to our patient, that initially had no ST segment elevation on the ECG but later progressed to ST segment elevation in leads II, III, and aVF [14-15]. These findings might raise awareness that Takotsubo cardiomyopathy can develop later, even after the precipitating stress (diabetic ketoacidosis) has subsided.

Most of the patients in the recent case report had either type 1 diabetes mellitus or poorly controlled type 2 diabetes mellitus and were insulin-dependent. While our patient was newly diagnosed and presented with a hyperglycemic crisis. Given her age and comorbidities, coronary angiography needs to be performed to differentiate her condition from ST-elevation myocardial infarction.

## CONCLUSION

Diabetic ketoacidosis-induced Takotsubo cardiomyopathy is not a very rare complication. Many case reports have demonstrated its occurrence in various clinical settings, including variations in age, sex, type of diabetes mellitus, and onset of cardiomyopathy. Physicians should be aware of this condition and give early recognition and prompt investigation to make the diagnosis and exclude life-threatening conditions such as ST elevation myocardial infarction.

**Table 1**. Previous case report of diabetic ketoacidosis induced Takotsubo cardiomyopathy.

| | Cureus, 2020 [14] | J Intensive Care Soc. 2015 Feb [15] | Cureus. 2022 Nov [2] | Acta Cardiol Sin. 2014 Nov [3] | BMJ Case Rep. 2013 Apr [4] | Ann Clin Biochem. 2009 May [5] | Case Rep Crit Care. 2017 Apr [6] | AACE clinical case report. 2017 [7] | JACC Archives 2021 [8] | CHEST Journal 2020 Oct [9] |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | 50 | 18 | 37 | 81 | 59 | 46 | 66 | 70 | 68 | 57 |
| Sex | Female | Male | Male | Female | Female | Female | Male | Female | Female | Female |
| DM status | T1DM | T1DM (newly diagnosed) | T2DM | T2DM | newly diagnosed | T1DM | newly diagnosed | T1DM | T1DM | T2DM |
| Initial ECG | Diffuse ST depression | Sinus tachycardia | Sinus tachycardia with RAD | Sinus tachycardia with ST elevation in V2-V4 | ST elevation II, III, aVF, v3-v5, J wave (v4-v6) | ST elevation II, III, aVF, v2-v6 | AF with RVR, ST elevation II, III, aVF, v3-v6 | Septal ST depression | AF with RVR | ST elevation in v3-v6, Q waves in v1-v2 |
| Diagnosis of TC | Day2 of admission | Upon arrival to the ICU | Upon arrival | Upon arrival | Upon arrival | Upon arrival | Upon arrival | Day4 of admission | Upon arrival | Upon arrival |
| Diagnostic ECG | ST elevation II, III, aVF, v3-v6 | ST elevation in lead II, III, aVF with RBBB | As initial ECG | | | | | | | |
| Echo | LVEF 25%, global hypokinetic LV | LVEF 15%, globalLV hypokinesis with apical akinesis/ dyskinesis, severely reduced RV systolic function | LVEF 30%, diffuse global hypokinesis | LVEF 35.4%, apical hypo to akinesia | Contractile failure of the left ventricular wall at the apex | LVEF 30%, left anterolateral wall hypokinesia and severe apical akinesia and ballooning | LVEF 30 – 40%, apical hypokinesia | Normal size LV with large apical aneurysm | LVEF 30 – 35%, mildly decreased LV systolic dysfunction, aoical, distal anteroseptal, and basal inferoseptal hypokinesis | LVEF 40 – 45% with anteroseptal and apical akinesia |
| CAG | normal | NA | NA | normal | normal | normal | Normal | NA | Minimal vessel disease | Normal |
| ECG resolution | NA | 3 days after onset | NA | NA | 2 days after onset | NA | NA | NA | NA | NA |
| Follow up Echo | NA | Day5; returned to normal LVEF | 2 wks; improved LVEF 60% | NA | 13 days after onset; a balloon-like left ventricular wall motion abnormality disappeared | 12 days; complete return of normal LV function and a correction of the regional wall motion abnormalities | 5 days; EF 45% with resolution of apical ballooning | 18 days; normal left ventricle size | NA | NA |

## ACKNOWLEDGEMENT
None

## AUTHORS' CONTRIBUTIONS
(I) Conceptualization: Surat Tongyoo; (II) Data curation: Napassorn Teeratakulpisarn, Saranthorn Purngcharoenkul; (III) Writing – original draft: Saranthorn Purngcharoenkul; (IV) Writing – review & editing: Napassorn Teeratakulpisarn, Surat Tongyoo.

## REFERENCES
1. Medina de Chazal H, Del Buono MG, Keyser-Marcus L, Ma L, Moeller FG, Berrocal D, Abbate A. Stress cardiomyopathy diagnosis and treatment: JACC State-of-the-Art review. J Am Coll Cardiol. 2018;72(16):1955-1971.
2. Abbas A, Patel N, Kazmi R, Mirza N, Miller R, Correia J. Diabetic ketoacidosis-induced cardiomyopathy and reversible dialysis-dependent renal failure with successful outcome: A report of a rare case. Cureus. 2022;14(11):e31711.
3. Wu WT, Hsu PC, Huang HL, Chen YC, Chien SC. A case of Takotsubo cardiomyopathy precipitated by thyroid storm and diabetic ketoacidosis with poor prognosis. Acta Cardiol Sin. 2014;30(6):574-7.
4. Katayama Y, Hifumi T, Inoue J, Koido Y. A case of Takotsubo cardiomyopathy induced by accidental hypothermia and diabetic ketoacidosis. BMJ Case Rep. 2013;2013:bcr2012008143.
5. Nanda S, Longo S, Bhatt SP, Pamula J, Sharma SG, Dale TH. Stress cardiomyopathy - a unique presentation of diabetic ketoacidosis. Ann Clin Biochem. 2009;46(Pt 3):257-60.
6. Gordon A, LaCapra G, Roberti R. DKA-induced Takotsubo cardiomyopathy in patient with known HOCM. Case Rep Crit Care. 2017;2017:4287125.
7. Jed H. Meyers, Irl B. Hirsch. Takotsubo cardiomyopathy in association with Dka in a blind pump patient. AACE Clinical Case Reports. 2017;3(1):e44-e45
8. Dickow M, Chaudhry S, Khanam V, et al. A case report of Dka-induced Takotsubo cardiomyopathy in a stiff person syndrome on IVIG. J Am Coll Cardiol. 2021;77:3006.
9. Khaing Khaing Htwe, Priya Patel, Hay Mar Soe. Association of diabetic ketoacidosis with Takotsubo cardiomyopathy. Chest. 2020;158(4):supplement
10. Lyon AR, Citro R, Schneider B, Morel O, Ghadri JR, Templin C, Omerovic E. Pathophysiology of Takotsubo syndrome: JACC state-of-the-art review. J Am Coll Cardiol. 2021;77(7):902-921.
11. Bybee KA, Kara T, Prasad A, Lerman A, Barsness GW, Wright RS, Rihal CS. Systematic review: transient left ventricular apical ballooning: a syndrome that mimics ST-segment elevation myocardial infarction. Ann Intern Med. 2004;141(11):858-65.
12. Templin C, Ghadri JR, Diekmann J, et al. Clinical features and outcomes of Takotsubo (stress) cardiomyopathy. N Engl J Med. 2015;373(10):929-38.
13. Prasad A, Dangas G, Srinivasan M, Yu J, Gersh BJ, Mehran R, Stone GW. Incidence and angiographic characteristics of patients with apical ballooning syndrome (Takotsubo/stress cardiomyopathy) in the HORIZONS-AMI trial: an analysis from a multicenter, international study of ST-elevation myocardial infarction. Catheter Cardiovasc Interv. 2014;83(3):343-8.
14. Mhanna M, Beran A, Srour O, Ghazaleh S, Elzanaty A. A case of Takotsubo cardiomyopathy triggered by diabetic ketoacidosis and hypothermia. Cureus. 2020;12(10):e10842.
15. Lane AS, Champion B, Orde S, Dravec D. Diabetic ketoacidosis due to fulminant type 1 diabetes: A rare subtype of type 1 diabetes leading to unusual sequelae. J Intensive Care Soc. 2015;16(1):64-70.