Takotsubo Cardiomyopathy: Role of Cardiac MRI

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ABSTRACT

We present a case of Takotsubo Cardiomyopathy (TC) which is a non ischemic cardiomyopathy. It is stress related and also known as broken heart syndrome. The patient presented to our emergency department with symptoms of chest pain and breathlessness. The patient was diagnosed as acute coronary syndrome and various tests including ECG, Screening ECHO, Coronary CT and Cardiac Magnetic Resonance (CMR) were done before arriving at the diagnosis of TC. Currently CMR is the modality of choice as it detects the wall motion abnormalities (WMA), presence of wall edema and late gadolinium enhancement (LGE) characteristics can be well appreciated. No intervention was done and the case was managed medically.

CASE REPORT

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A 67 year old lady was brought to our ER with symptoms of chest pain and breathlessness. The husband told that the symptoms started 30 minutes after hearing the news of her sister's demise.

This prompted our physician to think of TC and hence tests were done to confirm the diagnosis. The cardiac enzymes were mildly elevated but inconclusive. ECG showed mild to moderate ST elevation and left bundle branch block.

Echocardiography showed akinesia of the apical and mid-ventricular segment while the basal segments were hypercontractile. The apex was dilated (apical ballooning). Mild to moderate degree of left ventricular dysfunction was noted. Coronary CT was also done to assess the coronary arteries. The coronary CT did not show any significant occlusion of the coronary arteries. The CMR performed showed mild apical ballooning and wall motion abnormality involving the apical and mid ventricular segments. Patchy wall edema was noted in the mid and apical segments on fat suppressed sequence. LGE was not seen.

The patient was managed medically with beta blockers, Angiotensin Converting Enzyme Inhibitors and short-term anticoagulants. She was stabilised and discharged in good health after 4 days of admission. She was instructed to continue the medications and to review after 3 months.

DISCUSSION

Etiology & Demographics:

Takotsubo cardiomyopathy is a reversible cardiomyopathy. It is often precipitated by a stressful event. The clinical features are similar to acute myocardial infarction. Usually, women in the postmenopausal age group are affected. Takotsubo is a Japanese word meaning octopus trap. This reversible cardiomyopathy is characterized by hypokinesia or akinesia in the mid and apical segments of the left ventricular (LV) wall with typical sparing of the basal segments and with

absence of obstructive coronary lesions. The prognosis is excellent, and the LV function recovers completely. All these features are well seen on CMR [1]. Takotsubo is a pot used by the Japanese to catch octopus (Figure 1). While performing left ventriculography, Dote et al [2] first described Takotsubo cardiomyopathy, when he saw that the left ventricle actually resembled the Japanese pot to trap the octopus.

The importance of knowing about this disease entity and identifying the disease is very important because of its clinical similarity with other acute coronary syndromes (ACS) that require acute treatment and have a worse prognosis. TC is completely reversible with a good prognosis.

Pathophysiology:

The four theories explaining [3] the cause of the disease are:

1. Spontaneous thrombolysis of the thrombus formed in the coronary arteries.
2. Multiple coronary vasospasms.
3. Microcirculatory dysfunction.
4. Catecholamine stunning.

TC has been reported in up to 2.2% of patients presenting with ACS to the hospital, and as more physicians are becoming aware of this disease, this percentage will increase soon with an increase in the detection rate. Among the different diagnostic tools available, the role of CMR has significantly increased. CMR allows not only the morphologic and dynamic assessment of the heart but also shows the myocardial inflammation / scaring with the use of Gadolinium.

Clinical & Imaging findings:

MRI Imaging protocol

Cardiac MR imaging [4] in TC and other ACS needs to assess the presence or absence of structural abnormalities, to evaluate the presence of myocardial edema and scarring. MR scanners should be 1.5 T or higher with coils for cardiac imaging.

For structural abnormalities, T1 gated sequences in short and long axis and a four-chamber plane, as well as free precession breath-hold cines in short and long axis and outflow tract are useful. For myocardial edema, T2 weighted images with triple inversion recovery (IR) in the short and long axis, as well as a four-chamber acquisition is recommended. Lastly, to assess for the presence or absence of scarring, ten minutes after Gadolinium injection, short and long axis acquisitions identical to the ones done in cine mode are performed using an IR gradient echo sequence. The descriptions of the sequences we use clinically are given below in Table 1.

The modified Mayo Clinic diagnostic criteria [5] for Takotsubo cardiomyopathy are:

1. Presence of transient hypokinesia, akinesia, or dyskinesia in the LV mid and apical segments with wall motion abnormalities that extend beyond a single epicardial vascular distribution and frequently, but not always, of a stressful trigger.
2. Absence of obstructive coronary disease or angiographic evidence of acute plaque rupture.
3. New ECG changes with ST-segment elevation or T-wave inversion and usually elevation of cardiac markers
4. Absence of pheochromocytoma and myocarditis.

Edema

Edema is the result of an inflammatory process and has been proved by correlating with endomyocardial biopsies. In TC, the area of edema corresponds to the area of WMA, however it is difficult to differentiate it from edema due to other causes like myocarditis. Late gadolinium enhancement (LGE) is usually relied upon to differentiate, although myocarditis without LGE can also happen. The laboratory findings, the age of the patient and other imaging findings may help in the differential. Another indicator of the role inflammation plays in TC, is the slight association between wall edema and pericardial effusion [6]. Typically, T2-weighted sequences in TC patients shows the presence of circumferential, transmural oedema of the apical to mid-cavity myocardium matching with the regional wall motion abnormalities. Myocardial oedema is a transient dynamic phenomenon, normally progressively resolving between 3 to 6 months.

Myocardial edema (Figure 2 & 3) on CMR is a constant feature in TC, reflecting acute inflammation.

Left Ventricular function and Wall Motion Abnormalities:

The presence of a reversible systolic impairment of LV function affecting mainly the LV apex is one of the hallmark features of TC (Figure 4). The regional wall motion abnormality extends beyond a single epicardial vascular distribution. The typical form presents with contraction abnormalities in the ventricular wall, equally affecting the anterior, inferior and lateral walls, which extend beyond a single epicardial vascular territory. Another finding suggestive of TC is the hyperkinesia of basal segments contributing to the characteristic morphology.

A mid-cavity to apical ballooning with sparing of the LV basal segments occurs typically [7]. However, other contraction patterns that are observed during the acute phase of TC including mid-ventricular, basal and focal forms may be seen in up to 18 % of the cases [8] complete recovery in 96 % of patients occurs within 7−37 days. It has been observed that typical and mid-ventricular TC forms have more severe heart failure symptoms.

Late Gadolinium Enhancement (LGE):

To assess for the presence/absence of myocardial scarring. The edema of the myocardium usually resolves without any myocardial scarring leading to full functional recovery. The main use of LGE is to identify the presence and assess the amount of myocardial damage. Early CMR studies have shown that absence of LGE is a must for the diagnosis of TC (Figure 5). Lack of LGE differentiates it from MI and other cardiomyopathies [9].

However, some reports do say that LGE can be present in TC which may be due to delayed washout of the gadolinium due to increased interstitial water content.

Treatment & Prognosis:

TC is a condition which is medically managed. Supportive care is needed till the LV function is restored. Beta blockers and Angiotensin Converting Enzyme inhibitors are commonly used. These drugs promote the recovery of the muscle. To prevent clot formation short term use of anticoagulants is also advocated. The hospital stay of our patient was for 4 days (mean is between 3 – 7 days). Anti-anxiety or beta blockers are prescribed on long term basis to alleviate stress.

Complications:

The possible complications are: left heart failure with or without pulmonary edema, acute pericarditis, mitral valve regurgitation, ventricular arrhythmias, intramural thrombus, stroke, LV free wall rupture and even death [10]. Most of these complications are diagnosed with CMR.

Close follow up with a cardiologist is advised and complete recovery occurs within 3-6 months. Follow up imaging can be done with either ECHO or CMR.

Differential Diagnosis:

The findings are typical for TC and CMR will easily differentiate it from other condition like myocarditis, cardiomyopathy and ischemia. Ischemia usually involves the subendocardial or transmural enhancement depending on the amount of muscle layer involved. Non ischemic causes are differentiated based on the distribution of the delayed enhancement. Myocarditis usually involves mid myocardium.

TEACHING POINT

Takotsubo Cardiomyopathy is characterized by history of recent stress, absence of significant coronary artery stenoses, presence of wall edema, apical ballooning with wall motion abnormality (hypokinesia or akinesia in the mid and apical segments of the left ventricular (LV) wall with typical sparing of the basal segments and lack of LGE.

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FIGURES

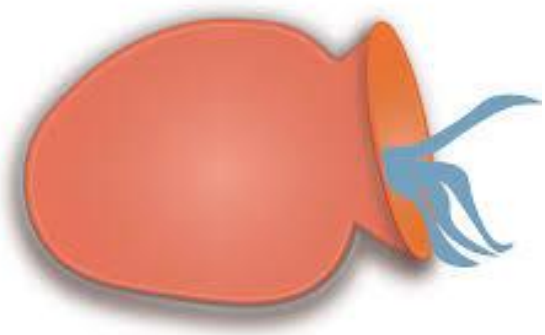

Figure 1 (left): Takotsubo (octopus trap) pot with a narrow neck used in Japan to catch octopus.

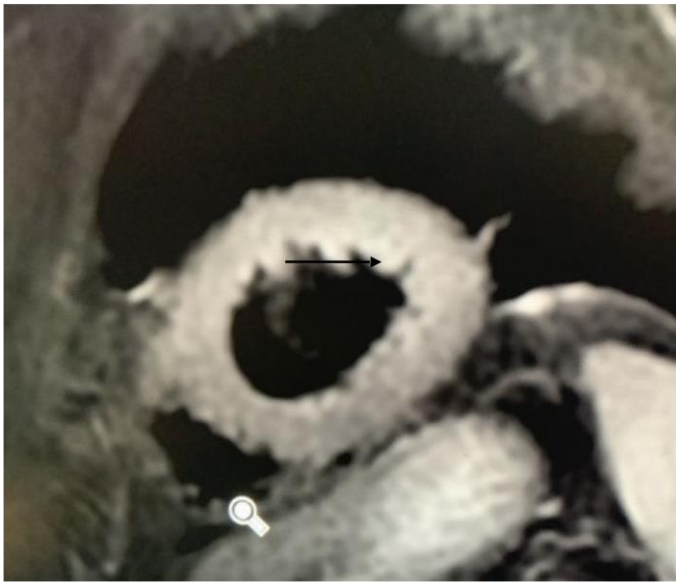

Figure 2: 67-year-old woman with Takotsubo cardiomyopathy.

Findings: Cardiac MR done on GE 3T MRI. Sagittal short axis STIR images of the left ventricle at the apical region showing patchy wall edema (black arrow).

Technique: TR 1600, TE 54, TA 107, 512 X 512 matrix, no contrast.

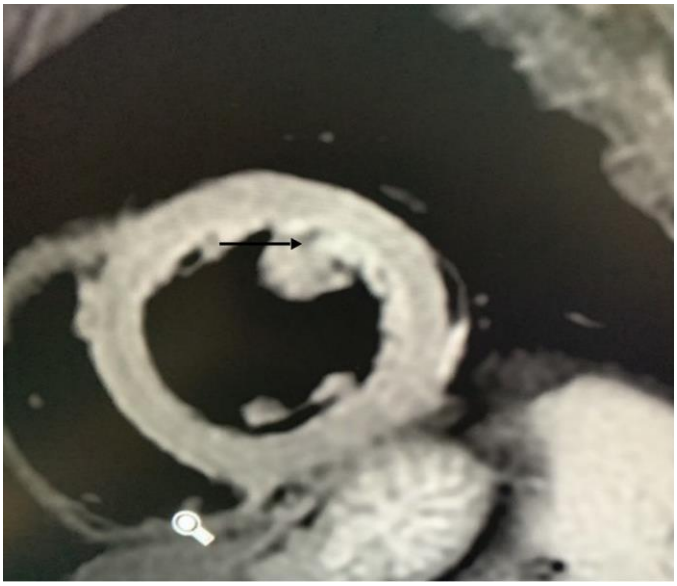

Figure 3: 67-year-old woman with Takotsubo cardiomyopathy.

Findings: Cardiac MR done on GE 3T MRI. Sagittal short axis STIR images of the left ventricle at the mid region showing patchy wall edema (black arrow).

Technique: TR 1600, TE 54, TA 107, 512 X 512 matrix, no contrast

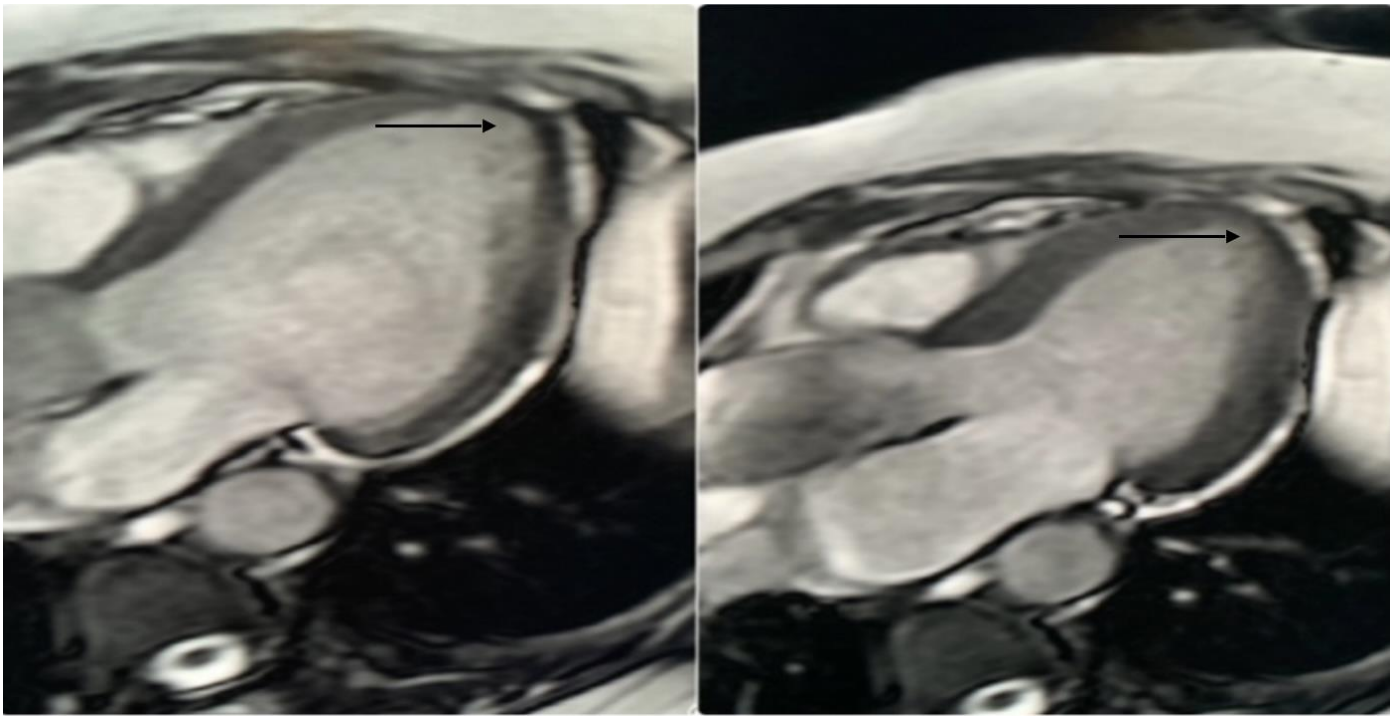

Figure 4: 67-year-old woman with Takotsubo cardiomyopathy.

Findings: Cardiac MR done on GE 3T MRI. Fig 4a, Axial 3 chamber white blood image at diastole and Fig 4b, Axial 3 chamber white blood image at systole shows ballooning of the left ventricle apex (black arrow) which is characteristic of TC.

Technique: TR 3.45, TE 1.40, TA 55, 512 x 512 matrix , no contrast.

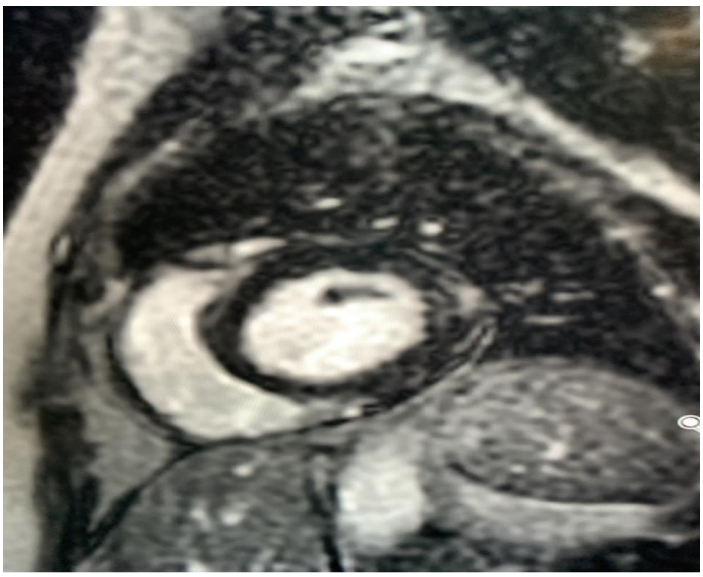

Figure 5 (left): 67-year-old woman with Takotsubo cardiomyopathy.

Findings: Post contrast Cardiac MR done on GE 3T MRI. Post contrast, short axis sagittal images of the left ventricle at the mid cavity showing no LGE.

Technique: TR 3.59, TE 1.45, TA 55, 512 x 512 matrix. Post contrast study done 10 mins after intravenous administration of gadolinium.

Protocol	Sequence	Planes	Usefulness and Current Utilization
Scout	Balanced Steady State Free Precession (bSSFP) Non-ECG-gated	Transaxial, coronal and sagittal covering the entire thorax	Standard for all CMR studies Easily identify pleural and pericardial effusions
Edema	Black blood T2-weighted (fast spin echo) triple-inversion recovery (IR)	Short-axis plane covering the LV Slice thickness = 8 mm	Recommended for differential distinction from myocarditis or acute MI. Usual finding is increase SI in mid-apical segments
T1-Mapping	Modified Look-Locker (MOLLI), Shortened Modified Look-Locker Inversion Recovery (ShMOLLI), saturation recovery single shot acquisition (SASHA), others	Short-axis plane covering the LV with specific TI = 100–5000 ms, collected using bSSFP readouts Slice thickness = 8 mm	Research tool that may serve as a complementary technique to T2-weighted imaging. Quantitative means to detect myocardial edema without the need for reference ROIs
T2-Mapping	T2-prepared single-shot SSFP sequence, Multiecho FSE (MEFSE), others	Matching short-axis T1	Application under research evaluation. T2 values more closely correlate with free water tissue content over T1-based techniques in suspected myocardial inflammation. It may offer a more stable and truly quantitative alternative for edema detection in cases when conventional T2-weighted imaging fails, especially in thin and rapidly moving walls
Morphology and Function	Balanced steady state Free precession (bSSFP)	Short-axis plane covering entire LV Long-axis - 3 slices each plane (2CH, 4CH and LVOT) Slice thickness = 6–8 mm Interslice gap = 2–4 mm	Mandatory for all CMR studies investigating TC. It will give information on the hallmark of the disease, regional abnormal contractility not related to coronary territory
LGE	10 min after Gd bolus 2D segmented IR gradient echo with or without Phase-Sensitive IR (PSIR) Single-shot or 3D versions of LGE can also be used.	Short-axis plane covering LV (especially mid-apical segments) Long-axis – 1 or more slice each plane (2CH, 4CH and LVOT) Slice thickness = 8 mm Interslice gap = 2	The usual finding in TC is absence of significant myocardial LGE by visual analysis. Quantitative analysis using software with a variety of thresholds techniques can detect small amounts of patchy LGE.

Table 1: List of commonly used Cardiac MR Sequences.

Etiology	Stress related, non-ischemic Cardiomyopathy
Prevalence	1 to 2 %
Clinical Presentation	chest pain, breathlessness (like Acute Coronary Syndrome)
Gender	More common in women
Age Predilection	Post-menopausal, mean age 66
Risk factors	Domestic abuse, death of relatives, natural calamities, accident or major trauma, arguments.
Treatment	Beta blockers, ACE Inhibitors, anticoagulants, alleviation of stress
Prognosis	Excellent. Completely reversible in 3-6 months.
Imaging findings	Wall motion abnormality with apical ballooning (ECHO and CMR), Wall Edema (CMR), No LGE (CMR)

Table 2: Summary table of Takotsubo Cardiomyopathy.

No	Condition	LGE pattern in CMR	Wall Edema	WMA
1.	**Takotsubo Cardiomyopathy**	No LGE	present	Apical ballooning and non-coronary distribution.
2	**Ischemic**	Subendocardial or Transmural	Absent	Absent
3	**Myocarditis, Hypertrophic cardiomyopathy**	Mid wall	Absent	regional
4	**Sarcoidosis, Myocarditis**	Subepicardial	In active disease	Focal thinning with non-coronary distribution

Table 3: Differential diagnosis table for Takotsubo Cardiomyopathy.

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ABBREVIATIONS

ACS = Acute Coronary Syndrome
CMR = Cardiac Magnetic Resonance
IR = Inversion Recovery
LGE = Late Gadolinium Enhancement
LV = Left Ventricle
TC = Takotsubo Cardiomyopathy
WMA = Wall Motion Abnormality

KEYWORDS

Takotsubo; Broken heart syndrome; chest pain; cardiac MRI; stress cardiomyopathy

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