CASE REPORT

Importance of temporal changes in myocardial strain in Takotsubo cardiomyopathy

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SUMMARY

Strain imaging is a sensitive marker of myocardial dysfunction and may be underused in Takotsubo cardiomyopathy (TC). We present a case of biventricular TC in which early improvement in left ventricular longitudinal strain predated subsequent improvement in ejection fraction. Early temporal patterns of strain of the left and right ventricles have not previously been described in TC. Our case illustrates how strain can be a sensitive marker for myocardial dysfunction and recovery in TC. Increased use of strain in TC may have further implications on prognosis and management.

BACKGROUND

Takotsubo cardiomyopathy (TC) is an acute and usually reversible heart failure syndrome. Mayo Clinic guidelines define the condition as: (1) systolic dysfunction of the left ventricle (LV); (2) absence of obstructive coronary artery disease (CAD) or acute plaque rupture; (3) abnormal ECG and/or troponin and (4) absence of myocarditis or pheochromocytoma.¹ Echocardiography is the standard imaging modality to detect TC.^{1,2} Strain imaging is a novel echocardiographic technique that has been shown to be useful in the diagnosis and prognosis of patients with TC.^{3–5} We present a case of biventricular TC which highlights the significance of both early and late temporal changes in strain measurements.

CASE PRESENTATION

A 79-year-old woman with history of CAD, atrial tachycardia status postatrioventricular (AV) nodal ablation and pacemaker implantation, hypertension and diabetes mellitus presented with acute-onset chest pain and exertional dyspnoea. Her symptoms began after receiving an upsetting text message. On presentation, she was afebrile with blood pressure 117/59, heart rate 62 bpm, respiratory rate of 18 and oxygen saturation of 98% on room air. On examination, she had jugular venous distension of 8 cm H₂O and bibasilar rales without murmurs or peripheral oedema. Serial troponin I measurements were minimally elevated at 0.23, 0.23 and 0.20 ng/mL. Brain natriuretic peptide was 2560 pg/mL. ECG showed ventricular paced rhythm with underlying atrial tachycardia and AV dissociation.

INVESTIGATIONS

Transthoracic echocardiogram (TTE) demonstrated normal LV size with LV ejection fraction (LVEF)

39%. The LV midwall and apical wall segments were hypokinetic with preserved contraction of the basal segments (see online supplementary video 1). The global longitudinal strain (GLS) of -6.2% was abnormal, with diminished regional strain in the midwall and apical wall segments (figure 1). The right ventricle (RV) also had hypokinesis of the apical wall segments and preserved function of the midwall and basal wall segments. The RV free wall strain was -18.0% and diminished at the RV apex in particular (figure 2). A coronary angiogram was obtained and showed CAD without any lesions $>50\%$ (figure 3). A ventriculogram was not done given the TTE results were already available and to minimise exposure to contrast dye.

DIFFERENTIAL DIAGNOSIS

TC was the most likely diagnosis given the history of an inciting event, mildly elevated biomarkers and characteristic TTE findings. Obstructive CAD, particularly in the left anterior descending (LAD) artery, was ruled out with a coronary angiogram. Acute myocarditis was also considered and could be evaluated with cardiac MRI. However, the diagnosis seemed unlikely given the lack of a preceding viral prodrome and TTE findings more consistent with TC. Therefore, a cardiac MRI ultimately was not pursued.

TREATMENT

The patient was given intravenous furosemide on presentation. She was also treated with ramipril and spironolactone, which were continued throughout the follow-up period. Beta-blockers were started during the hospitalisation, but the patient was unable to tolerate due to presyncope.

OUTCOME AND FOLLOW-UP

Two days after initial presentation, a repeat TTE showed no change in LVEF; however, the strain polar map had significantly improved in the midwall and apical wall segments with GLS of -10.1% . The RV free wall strain had slightly improved to -21.0% , but the apical segment remained diminished. Three months later, there was normalisation of LVEF 66% and GLS -19.1% by TTE. The RV size and function were also normal by 3 months and RV free wall strain had improved to -32.3% . Eighteen months prior to presentation, the patient had TTE findings similar to 3-month follow-up with LVEF 66% and GLS of -18.7% .

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Time	18 months prior	Presentation	2 days	3 months
GLS	-18.7%	-6.2%	-10.1%	-19.1%
LV EF	66%	39%	40%	66%

Figure 1 Temporal changes in LV longitudinal strain polar maps show abnormal values at presentation in the midwall and apical wall segments and early improvement in LV longitudinal strain. Long-term TTE findings resemble LV EF and GLS values prior to presentation. GLS, global longitudinal strain; LV EF, left ventricular ejection fraction; TTE, transthoracic echocardiogram.

DISCUSSION

Echocardiography is essential to the diagnosis of TC and used to assess ventricular size and function, identify potential adverse sequelae and monitor recovery. Strain imaging for diagnosis and assessing recovery in TC is underused. In this case of biventricular TC, we highlight (1) the utility of early temporal changes in LV longitudinal strain and (2) changes in RV free wall strain over time.

Most patients with TC have improvement in LVEF within 12 weeks but it is unclear if and when longitudinal strain improves.² Early temporal changes in LV longitudinal strain and LVEF have not been previously described in TC. It is possible early changes in LV longitudinal strain may have prognostic value in TC and consequent implications for patient management. Potential changes include degree of surveillance, initiation or

discontinuation of medications or duration of therapy. In our case, LV longitudinal strain improved within 2 days, prior to LVEF recovery. Early improvement in LV longitudinal strain in TC may predict subsequent recovery in LVEF. On the other hand, studies have shown abnormal LV longitudinal strain persists in TC after normalisation of LVEF in some patients.³ Perhaps, patients without early improvement in LV longitudinal strain may be more likely to have persistent myocardial dysfunction despite normalisation of LVEF.

TC and obstructive CAD in the LAD artery can often have similar presentations. Myocardial strain imaging can be used to non-invasively differentiate between the two conditions based on temporal changes and anatomic patterns. Early improvement in LV longitudinal strain without a revascularisation intervention is more likely in TC compared with obstructive

Time	Baseline	2 days	3 months
RV Free Wall Strain	-18.0%	-21.0%	-32.3%

Figure 2 Temporal changes in RV free wall strain show abnormal baseline value in the apical segment with no significant early changes but long-term normalisation. RV, right ventricle.

Figure 3 Coronary angiogram demonstrating coronary artery disease without any lesions >50%.

CAD.^{4 5} Additionally, our case has abnormal strain in midwall and apical LV wall segments supplied by multiple coronary territories, making obstructive CAD a less likely diagnosis.^{1 2 6} Having abnormal RV free wall strain, as seen in our case, is also more likely to occur in TC compared with obstructive CAD.⁶ The strain polar map pattern of acute TC has been described as a 'fish eye', progressively worsening from the basal to the apical wall segments in a circular pattern without following a coronary distribution.⁷

In our case, RV free wall strain had minimal improvement at 2 days but was completely normal at 3 months. Complete recovery of RV free wall strain has been shown in most patients with biventricular TC.⁸ Therefore, unlike the LV, early improvement in RV free wall strain may not occur despite eventual improvement in RV systolic function. This pattern of slow, but complete recovery of RV function has also been demonstrated in RV ischaemia and may add credence to catecholamine-induced subendocardial ischaemia as a contributing mechanism of TC.^{9 10} Right ventricular involvement in TC is being recognised more

commonly with a reported incidence of 13% to 50%, and is associated with worse in-hospital and long-term outcomes.^{1 8 10 11} Assessment of RV dysfunction by two-dimensional echocardiography (2D echo) is difficult, particularly when regional wall motion abnormalities make techniques such as tricuspid annular plane systolic excursion less useful. Strain imaging has been used as a quantitative measure of RV dysfunction.^{12 13} Although there was suggestion of RV apical hypokinesia on 2D imaging in our patient, strain analysis confirmed and quantified this finding. A retrospective study showed that RV peak systolic strain >−19.1% suggested RV involvement in TC with a sensitivity of 85% and specificity of 71%.¹²

In this case of biventricular TC, we report early and long-term changes in LV and RV strain, which have not previously been described. For this patient, early improvement in LV longitudinal strain may have suggested a favourable prognosis by preceding normalisation in LVEF. There are limitations to generalising findings from this particular patient, but this case can be hypothesis generating for further investigation into temporal changes in LV and RV strain in TC.

Contributors All authors were involved in planning, conception and design, analysis and interpretation of data, and writing of the manuscript.

Competing interests None declared.

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Learning points

- In this patient with Takotsubo cardiomyopathy (TC), early improvement in left ventricular (LV) longitudinal strain had prognostic value by predating changes in left ventricular ejection fraction. Alternatively, patients with persistently abnormal strain in TC may have continued myocardial dysfunction requiring treatment.
- Temporal changes in right ventricle (RV) free wall strain differed from LV longitudinal strain and may provide insight into the mechanism and natural history of RV involvement in TC.
- The temporal changes and anatomic distribution in strain imaging was useful in differentiating TC from obstructive coronary artery disease (CAD).
- Overall, strain imaging should be considered more routinely in patients with TC to potentially provide prognostic value, impact treatments and differentiate from obstructive CAD.
- Further investigation is needed to better validate the findings presented in this case and evaluate implications on prognosis and management.

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