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Unique Morphological Variations of Transient Midventricular Syndrome: A Case Series-Review

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Abstract

Older individuals (especially women) enduring an inciting emotional or physical event are prone to developing left ventricular ballooning syndrome. Ballooning of apical distribution is the most common type. However, a midventricular variant is increasingly reported. As this variant becomes further delineated, we describe a case series in which various morphological patterns of midleft ventricular segments are seen. Each case involves a female patient with a presumptive diagnosis of acute coronary syndrome, who upon further cardiac workup demonstrated normal epicardial coronary blood flow. Subsequent cardiac imaging, including transthoracic echocardiography, revealed unique midventricular dilation and akinesis, with preserved or hypercontractility of the basal and apical segments. However, more unique to this, was the fact that the left ventricular regional wall motion abnormalities were of either “symmetric” ballooning morphology, involving all mid segments of the left ventricle; or more dramatically, “asymmetric” ballooning morphology, which involves abnormal regional motion of only a focal left ventricular wall. Furthermore, we review current literature on midventricular ballooning and propose likely mechanisms and optimal treatment strategies in the face of potential complications of midventricular ballooning syndrome.

Keywords

midventricular ballooning; cardiomyopathy

Takotsubo cardiomyopathy, first described in Japan in 1991,¹ is a rare syndrome within the spectrum of acute coronary syndrome (ACS). It has alternatively been referred to as transient left ventricular dysfunction syndrome, left ventricular ballooning syndrome, stress cardiomyopathy, apical ballooning syndrome, or broken heart syndrome. This distinct disease entity typically manifests apical wall motion abnormalities of the left ventricle (LV) without obstruction of corresponding coronary artery. Recently, another variant involving the circumferential midventricular region of the LV has been identified.²

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Supporting Information

Additional Supporting Information may be found online on Wiley Online Library.

Movie clip 1: Case 1 TTE at presentation. Note: Hypercontractile motion of apex and base with midventricular hypokinesis.

Movie clip 2: Case 2 TTE at presentation. Note: Focal midanteroseptal hypokinesis.

Movie clip 3: Case 3 TTE at presentation. Note: Hypercontractile motion of apex and base with midventricular hypokinesis.

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Unlike the apical ballooning initially described in Takotsubo cardiomyopathy, midventricular ballooning dysfunction, as the name suggests, reveals midventricular dyskinesis with sparing of the apex and the base, and presents potential complications induced by left ventricular basal hyperkinesis, such as left ventricular outflow tract (LVOT) obstruction.³ Here we describe a unique variant in the forms of limited and focal involvement of the mid-LV segments, thereby presenting a novel subtype within the expanding classification of the left ventricular ballooning syndrome.

Case Report 1

An 81-year-old female with a medical history significant for hypertension, hyperlipidemia, and anxiety presented to emergency room with complaints of a new, acute onset of chest pain preceding extreme emotional stress. The patient's home medication included daily aspirin and lisinopril. Physical examination revealed a stable, well nourished, and afebrile female with blood pressure of 115/66 mmHg, heart rate 101 beats/min. The remainder of physical exam was unremarkable.

Admission electrocardiogram (ECG) revealed normal sinus rhythm with rate of 86 beats/min and nonspecific T-waves abnormalities with flattening across precordial leads V₁-V₄. Cardiac enzymes were elevated with peak troponin I noted to be 1.2 ng/mL (normal <0.030). A transthoracic echocardiogram (TTE) revealed ejection fraction (EF) of approximately 45%, with regional wall motion abnormalities consisting of akinesis of the midanteroseptal, midinferoseptal, midinferolateral, midanterolateral, midanterior, and midinferior segment, although all other remaining segments remained normal (Fig. 1, movie clip 1). With the presentation suggestive of unstable angina and thrombolysis in myocardial infarction (TIMI) score of 3,⁴ patient was treated with aspirin, atorvastatin, metoprolol tartrate orally, and sublingual nitroglycerin. Heparin and eptifibatide infusion was also initiated. Subsequent coronary angiogram revealed normal epicardial coronary arteries. Left ventriculogram revealed hyperkinetic apical and basal segments, with global midventricular hypokinesis (Fig. 1).

Patient was medically managed, with no subsequent episodes of chest pain and resultant downtrending cardiac enzymes. Patient was discharged without further complications on hospital day 4. Follow-up TTE 2 months after initial presentation revealed normalized systolic function without any wall motion abnormalities (Fig. 2).

Case Report 2

A 77-year-old Asian female with history of hypertension, hyperlipidemia, and chronic obstructive pulmonary disease presented to the emergency department with one day history of substernal, nonradiating, nonexertional chest pain associated with mild shortness of breath at rest. Pertinent current medications included metoprolol, and atorvastatin. Of note, patient had been under a considerable amount of emotional and physical stress recently while dealing with her husband's progressive Alzheimer's disease. Physical examination revealed a well nourished female of stated age with a blood pressure of 124/81 mmHg and heart rate of 94 beats/min. The physical exam including cardiovascular exam was unremarkable.

ECG at the time of admission revealed normal sinus rhythm with rate of 74 beats/min and nonspecific T-wave abnormalities in leads I and augmented vector left (aVL). Cardiac biomarkers were mildly elevated with the troponin I noted at 1.69 ng/mL. Subsequent cardiac catheterization revealed normal coronary arteries; however left ventriculogram exhibited midventricular dilation with a hypercontractile base and apex (Fig. 3). TTE revealed distinct focal midanteroseptal akinesis of the LV, with no wall motion abnormalities in the apical or basal segments (Fig. 3, movie clip 2). She had episodes of hypotension that required inotropic support. The possibility of LVOT obstruction due to asymmetric midventricular wall motion abnormalities was ruled out via TTE.

Patient was medically managed with initial aggressive fluid management, and then later with lisinopril, metoprolol succinate, aspirin, and atorvastatin as blood pressure (BP) stabilized. There were no subsequent episodes of chest pain and resultant downtrending cardiac enzymes. Follow-up TTE 4 days after admission demonstrated recovered left ventricular systolic function with EF at 50–55% and improved midventricular wall motion abnormalities (Fig. 4).

Case Report 3

A 60-year-old Hispanic woman with a history of untreated hyperlipidemia and anxiety, and a family history of coronary artery disease (CAD) presented to the emergency department with complaints of chest discomfort starting one day prior. Patient was a self-admitted “type A personality” and a history of severe antecedent emotional stress was reported.

Physical exam demonstrated blood pressure 128/80 mmHg, heart rate of 85 beats/min. The physical exam including cardiovascular exam was unremarkable. Admission ECG showed normal sinus rhythm at a rate of 89 beats/min with T-wave inversions in leads V₃-V₆. Troponin I was elevated to 1.8 ng/mL. Initial TTE revealed an EF of 40% with a severely hypokinetic mid-LV and corresponding hyperkinetic basal and apical segments, also seen in left ventriculogram (Fig. 5, movie clip 3). Cardiac catheterization revealed normal epicardial coronary arteries. Patient was managed with metoprolol succinate and aspirin, and discharged without further complication. TTE performed 6 months following the initial event revealed normalized left ventricular function with EF of 62% and no regional wall motion abnormalities (Fig. 6).

Discussion

In patients presenting with ACS, the incidence of left ventricular ballooning has been reported to be 1–2%,^{5–7} with at least 60% of the ballooning to be at the apex.² The LV ballooning syndrome is disproportionately more prevalent in women, specifically in postmenopausal women, who often present with a preceding stress-induced trigger.⁸ It can present with clinical manifestations suggestive of an obstructive coronary process, with symptoms of chest discomfort at rest, shortness of breath, syncope, or shock. Diagnostic workup often reveals ECG patterns suggestive of myocardial infarction and elevated cardiac biomarkers. Notably, however, the degree of cardiac enzyme elevation is not proportional to observed ECG abnormalities or presenting clinical features.^{9,10}

Imaging often reveals hypercontractile or normal mid/basal segments, with defining akinesia and ballooning of the apex.^{11,12} The current diagnostic criteria for apical ballooning syndrome as established by Western literature includes: (1) Transient akinesis of left ventricular apex resulting in apical ballooning, with either normal or hypercontractile midventricular and basal segments, (2) regional wall motion abnormalities extending beyond single epicardial vascular distribution, (3) no angiographic evidence for plaque rupture or intracoronary thrombus formation, (4) new ECG changes (ST-segment elevation or T-wave inversion), and (5) absence of recent head trauma, intracranial bleed, pheochromocytoma, myocarditis, or hypertrophic cardiomyopathy (HCM).¹²

Recently, a midventricular ballooning variant has been identified.^{2,13,14} These reports have described the global circumferential involvement of the entire mid-LV.^{13,14} We now describe a novel variant which involves only focal segments of the mid-LV. As such, midventricular ballooning may be subclassified into “symmetric” or “asymmetric,” with the former representing global, circumferential wall motion abnormality of the entire midventricle (Case 1 and Case 3) and the latter a localized akinesis within the midventricle, as illustrated in Case 2.

Although the exact pathophysiology of the LV ballooning syndrome is yet to be elucidated, the association with a specific emotional or physical stress has led some to hypothesize catecholamine excess to play a central pathologic role.¹⁵ Myocardial stunning or even myocardial toxicity can be a sequela of diffuse catecholamine-induced microvascular dysfunction.¹⁶ In addition, abnormal TIMI frame counts on angiography further support the notion of possibly catecholamine-induced vascular dysfunction.¹⁷ Studies evaluating TIMI myocardial perfusion grade and Doppler-wire derived assessment of coronary flow reserve have shown that microcirculatory disturbance accounts for up to 70% of patients presenting with left ventricular ballooning.^{18–20} Other mechanisms have been postulated, including impaired fatty acid metabolism, ACS with reperfusion and transient LV outflow obstruction, and myocarditis.^{21–28} The true etiology may be multifactorial, with the aforementioned disturbances collectively contributing in varying degrees to the spectra of left ventricular dysfunction.

Treatment for midventricular ballooning syndrome is supportive for the most part, given its often transient nature. Usually, the rapid resolution of clinical symptoms and ECG changes is observed after mitigation of provoking physical or emotional stressors. Although an optimal medical regimen has yet to be established for LV ballooning syndrome, a typical supportive treatment is similar to that for decompensated LV failure, and includes use of diuretics, beta-blockers, and aldosterone converting enzyme inhibitors.¹²

The LV ballooning syndrome is not without complications. For example, accentuated left ventricular basal hyperkinesis may lead to LVOT obstruction, analogous to that seen in HCM. Hypotension, cardiogenic shock, or severe mitral regurgitation is reported in up to 18% of cases.^{12,29} In such circumstances, urgent imaging with echocardiography is necessary to assess for possible LVOT obstruction, as its presence or absence dictates downstream management strategies.

In the setting of shock in patients with mid-LV ballooning with no associated LVOT obstruction, treatment may need to include inotropic agents (to be used with caution, as relative catecholamine excess or hypersensitivity has been implicated). In contrast, for those patients presenting with shock and LVOT obstruction, ideal management may not include inotropic support, which may exacerbate the LV outflow.^{29,30} Instead, improving hemodynamics with fluid resuscitation and judicious use of beta blockers, similar to treatment of HCM, may be more appropriate.^{12,29} The use of intraaortic balloon pump may be indicated in severe LV compromise with shock, analogous to Killip class III/IV classification of acute myocardial infarction due to CAD.

Prognosis of patients with mid-LV ballooning syndrome remains generally favorable, though reported mortality rate varies from 0–8%.^{8,12,21,30} Full LV function recovery is usually expected within 1–4 weeks.^{21,25,30–32} Nevertheless, a recurrence rate as high as 10% has been reported.¹⁸

Conclusion

Although less common than apical ballooning, the midventricular variant of the left ventricular ballooning syndrome is increasingly identified. Within the recognized midventricular ballooning, we report distinct subtypes: “symmetric,” involving the global midventricular ballooning, or “asymmetric” type, with more localized akinesis within the midventricle. In addition to supportive therapy, early identification of possible subsequent LVOT obstruction may be important in downstream treatment strategies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Case 1 transthoracic echocardiogram (TTE) and left ventriculogram at presentation. **A.** (Top left) end systolic frame depicting uniform ballooning throughout the contour of the midventricle. **B.** (Top right) end-diastolic frame. **C.** (Bottom left) end-diastolic left ventriculogram. **D.** (Bottom right) end-systolic left ventriculogram. Note: Hypercontractility of basal and apical regions with ballooning of midventricle.

Figure 2.
Case 1 follow-up TTE. **A.** (Left) end-diastolic frame attained 2 months after initial TTE. **B.** (Right) end-systolic frame, revealing resolution of symmetric midventricle ballooning dysfunction noted on earlier TTE.

Figure 3.

Case 2 TTE and left ventriculogram at presentation. **A.** (Top left) TTE end-systolic frame depicting focal wall "asymmetric" ballooning of the midventricle. **B.** (Top right) TTE end-diastolic frame. **C.** (Bottom left) left ventriculogram in systole depicting midventricular hypokinesis with concurrent hyperkinesis of apex and base. **D.** (Bottom right) left ventriculogram in diastole.

Figure 4. Case 2 follow-up TTE. **A.** (Left) end-systolic frame 4 days after initial TTE, revealing resolution of asymmetric midventricle ballooning dysfunction noted on earlier TTE. **B.** (Right) end diastolic frame.

Figure 5. Case 3 TTE and left ventriculogram at presentation. **A.** (Top left) TTE end-systolic frame depicting “symmetric” ballooning of the midventricle. **B.** (Top right) TTE end-diastolic frame. **C.** (Bottom left) left coronary artery tree depicting no occlusive lesions. **D.** (Bottom right) right coronary artery tree depicting no occlusive lesions.

Figure 6.

Case 3 follow-up TTE. **A.** (Left) end-systolic frame attained 6 months after initial TTE, revealing resolution of symmetric midventricle dysfunction noted on earlier TTE. **B.** (Right) end-diastolic frame attained 6 months after initial TTE, depicts normal diastolic relaxation.