Case Reports

Left Ventricular Noncompaction Cardiomyopathy

Presenting with Heart Failure in a 35-Year-Old Man

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Isolated ventricular noncompaction, a rare genetic cardiomyopathy, is thought to be caused by the arrest of normal myocardial morphogenesis. It is characterized by prominent, excessive trabeculation in a ventricular wall segment and deep intertrabecular recesses perfused from the ventricular cavity. The condition can present with heart failure, systematic embolic events, and ventricular arrhythmias. Two-dimensional echocardiography is the typical diagnostic method. We report a case of heart failure in a 35-year-old man who presented with palpitations. Two-dimensional echocardiograms revealed left ventricular noncompaction, which markedly improved after standard heart failure therapy.
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Isolated ventricular noncompaction (IVNC) is a rare genetic cardiomyopathy characterized by excessively prominent ventricular trabeculations and deep intertrabecular recesses. It is thought to arise in utero from arrested compaction of a loose myocardial meshwork. The major clinical presentations of left ventricular noncompaction (LVNC) are heart failure, arrhythmias, and thromboembolism. The diagnosis is established with use of 2-dimensional echocardiography or cardiac magnetic resonance (CMR).

We report the case of a patient with dilated cardiomyopathy and LVNC, and we discuss the effects of standard heart failure therapy on his condition.

Case Report

In March 2011, a 35-year-old man presented at a cardiology outpatient clinic with a several-week history of palpitations. His medical history yielded nothing relevant, and routine laboratory test results were normal. His chest radiograph showed mild cardiomegaly and normal lung fields. Physical examination revealed normal heart sounds and a mild systolic murmur heard best at the apex. A 12-lead electrocardiogram (ECG) showed sinus rhythm with poor R-wave progression and T-wave inversion in the precordial leads. A transthoracic echocardiogram (TTE) revealed a dilated left ventricle (LV), a depressed LV ejection fraction (LVEF) of 0.25, and moderate mitral regurgitation. A coronary angiogram revealed normal results. A 24-hour ECG showed frequent premature ventricular complexes and runs of nonsustained ventricular tachycardia.

Results of a CMR study included a markedly dilated LV with an LVEF of 0.19, an end-diastolic volume of 395 mL, and an end-systolic volume of 319 mL (Fig. 1). Prominent trabeculations were seen in the apical segments and lateral wall of the LV (Fig. 2). The ratio of noncompacted-to-compacted myocardium was 3.35:1. The indexed LV mass was 76 g/m^2 with no evidence of hypertrophy. Right ventricular (RV) size, function, and wall structure were normal. Delayed myocardial gadolinium enhancement produced subtle mid-wall stripes along the anterior and lateral LV wall and the inferior half of the interventricular septum. There was also marked myocardial wall-thinning, particularly of the apical segments. The left atrial diameter was 36 mm. The diagnosis was LVNC with heart failure. The patient was started on perindopril and carvedilol, with gradual upward titration.

Because of the patient's ventricular tachycardia and low LVEF, we referred him for implantable cardioverter-defibrillator placement. However, according to the im-

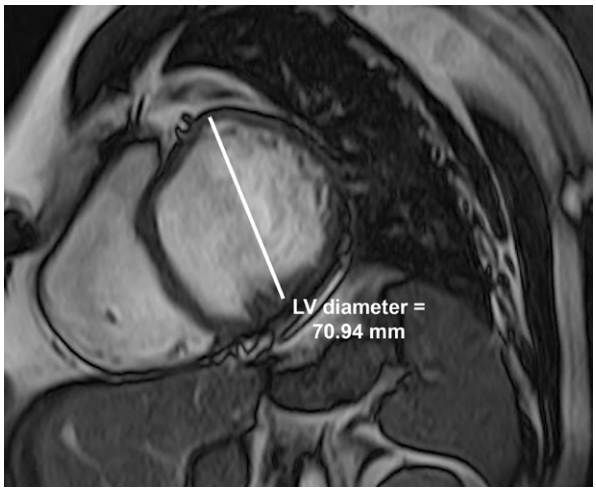

Fig. 1 *At presentation, a cardiac magnetic resonance image (short-axis, mid-cavity view) at end-diastole reveals the markedly dilated left ventricle (LV).*

plantation team, the installed device's LV lead showed high impedance with no capture, indicating that it was nonfunctional. The unit was completely explanted, repeat ECG monitoring was suggested, and carvedilol was increased to 6.25 mg twice daily. Three months later, a 24-hour ECG showed sinus rhythm, infrequent premature ventricular complexes, and no ventricular tachycardia. Thereafter, carvedilol was titrated to 25 mg and perindopril to 5 mg, both twice daily.

Ivabradine (5 mg twice daily) was added in 2013. Two years after initial presentation, CMR revealed substantial improvement in LVEF (0.63), end-diastolic volume (231.46 mL), and end-systolic volume (85.3 mL); no LV dilation (Fig. 3A); and a thickness ratio of noncompacted-to-compacted myocardium of 2.1:1, indicating complete myocardial recovery (Fig. 3B and Table I). The indexed LV mass was 63 g/m^2. A TTE confirmed the improvement in LV size and function (Table I) and revealed mild mitral regurgitation. The patient's mother, father, sister, paternal aunt, 2 paternal cousins, and a maternal cousin underwent TTE and ECG testing for IVNC, and nothing abnormal was found. As of June 2017, the patient was doing well.

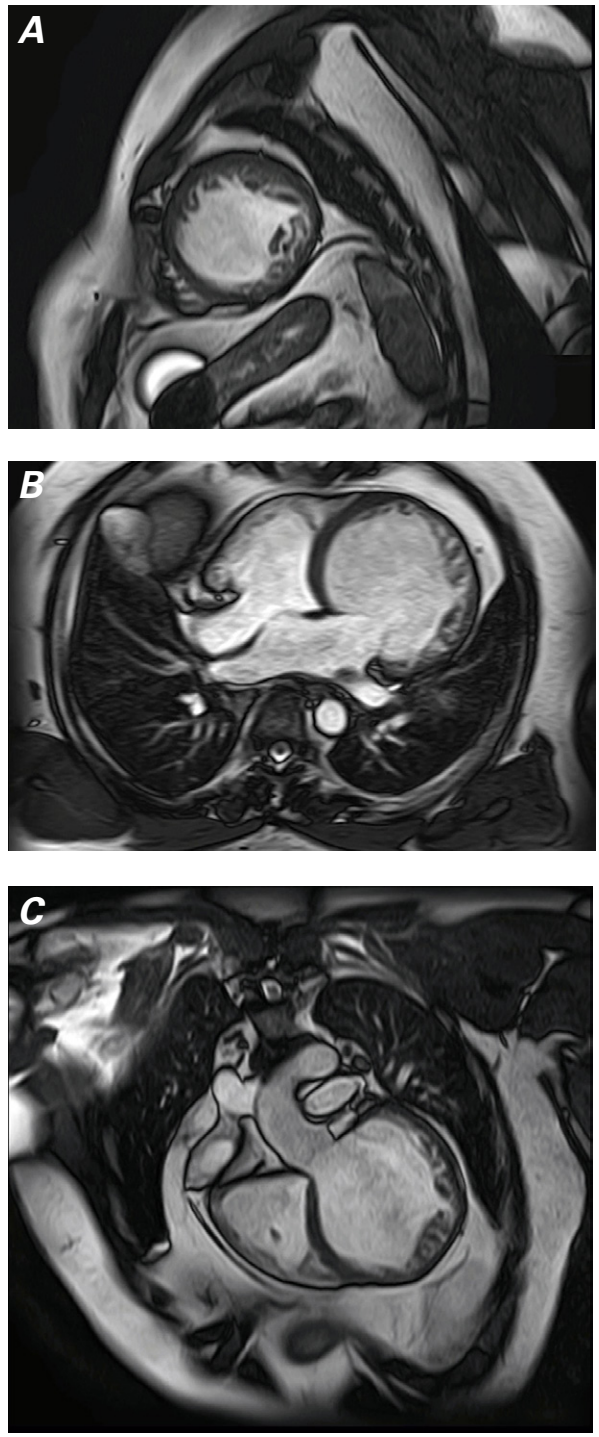

Fig. 2 *At presentation, cardiac magnetic resonance images show the globally hypokinetic left ventricle and noncompacted myocardium in **A**) short-axis, white-blood view, **B**) 4-chamber, white-blood view at the lateral wall and apex, and **C**) coronal oblique view parallel to the left ventricular outflow tract.*

Supplemental motion images are available for Figure 2A, Figure 2B, and Figure 2C.

Discussion

The prevalence of IVNC in adults is 0.05%.[1] Although it is usually observed in the LV, the RV can also be affected.[2] The condition is thought to be caused by arrested myocardial development in utero. During the first weeks of gestation, prominent myocardial trabeculations communicate with the ventricular cavity to supply blood to the myocardium. After the coronary circulation develops, the myocardial trabeculations disappear, and the spongy myocardium transforms into compact musculature.[1,3] Abrupt interruption of this process is thought to cause IVNC.

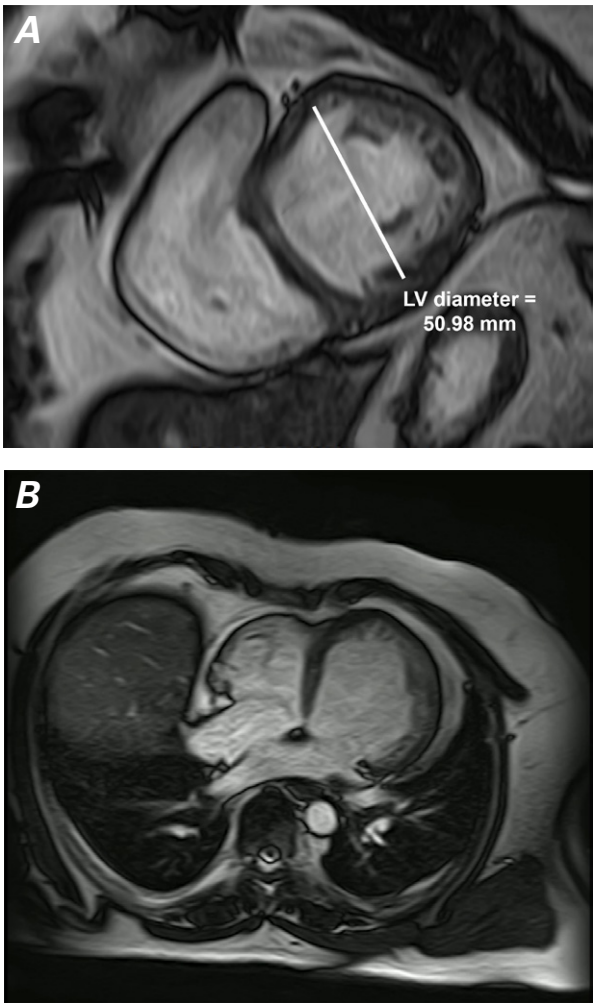

Fig. 3 *Cardiac magnetic resonance images.* ***A****) After 2 years, the short-axis, white-blood view shows decreased dilation and hypokinesia of the left ventricle (LV) at end-diastole.* ***B****) The 4-chamber, white-blood view shows improved LV contractility.*

Supplemental motion images are available for Figure 3A and Figure 3B.

TABLE I. Left Ventricular and Hemodynamic Measurements at Presentation and Follow-Up

Variable	Presentation	2-Year Follow-Up
Transthoracic echocardiography		
LV end-diastolic diameter (mm)	70	50
LV end-systolic diameter (mm)	52.5	20
LV ejection fraction	0.25	0.60
Cardiac magnetic resonance		
LV end-diastolic volume (mL)	395	231
LV end-systolic volume (mL)	319	85
LV ejection fraction	0.19	0.63
Diastolic myocardial thickness (mm)		
Noncompacted	13.4	11
Compacted	4	5.2

LV = left ventricular

Anatomically, IVNC is characterized by deep trabeculations in the ventricular wall; defined recesses communicate with the main ventricular cavity. The clinical presentation of IVNC depends upon the extent of the noncompacted cardiac segments. Individuals with IVNC can be asymptomatic, or they might experience heart failure, arrhythmias, or thromboembolism.[4-6]

Echocardiography is the usual method for diagnosing IVNC.[7] The diagnostic criteria are typically those proposed by Jenni and colleagues[8] and Frischknecht and associates.[9] Jenni and colleagues' criteria include 1) a markedly thickened LV wall of 2 layers (a thin, normally compacted epicardial layer and a markedly thickened endocardial layer with numerous prominent trabeculations and deep recesses); 2) no coexisting cardiac abnormalities; 3) blood flow between the intertrabecular recesses, identified with use of color-flow Doppler echocardiography; and 4) a maximum ratio of noncompacted-to-compacted myocardium of >2:1 at end-systole.

In any image plane, CMR reveals more detailed cardiac morphology than does echocardiography and should be used in the diagnosis of IVNC when echocardiographic windows are poor.[10] A >2.3:1 ratio of noncompacted-to-compacted myocardium yields the highest diagnostic sensitivity (86%) and specificity (99%).[10,11] Late gadolinium hyperenhancement is related to myocardial fibrosis and scarring in the hypertrabeculated myocardium.[12] Differential diagnoses include prominent normal myocardial trabeculations, false tendons, localized LV hypertrophy, LV thrombus, intramyocardial hematoma, arrhythmogenic RV dysplasia, endocardial fibroelastosis, cardiac metastases, and intramyocardial abscesses.

The treatment of IVNC is directed toward preventing thromboembolism, arrhythmias, and heart failure.[3,13] Prophylactic anticoagulation is generally indicated in cases of LV systolic dysfunction, previous embolic events, cardiac thrombus, and atrial fibrillation.[14,15] Proper therapy for heart failure, involving angiotensin-converting enzyme inhibitors, β-blockers, and appropriate diuretics or dioxin, is essential. Cardiac resynchronization therapy can be helpful in drug-refractory cases. In selected patients who have advanced heart failure, cardiac transplantation should be considered.[3]

Patients with IVNC should be screened by means of 24-hour ECG recordings to exclude asymptomatic arrhythmias. Implantable cardioverter-defibrillator placement may be considered for managing ventricular arrhythmias; however, its superiority to medical therapy is debatable.[7]

The long-term prognosis for patients with IVNC depends on the degree and progression of heart failure, the presence of thromboembolic events, and any arrhythmias. Oechslin and colleagues[13] reported a mortality rate of 35% during a mean follow-up period of 44 ± 39 months, and another 12% of their patients underwent heart transplantation. In contrast, Murphy and associates[16] noted improved prognoses in comparison with previous studies. Better recent prognosis might be attributed to earlier detection of the disease and more aggressive treatment of symptomatic patients. A much better prognosis has been noted in patients with fewer involved LV segments than in those with more.[17]

Left ventricular geometry—the relationship between LV shape and function and visible LV trabeculations—might explain the reversibility of hypertrabeculation after optimal medical therapy has improved LV function.[18] We used the ratio of involvement to LV cavity size as the most important diagnostic criterion in our patient.

Our patient's LV size and function recovered to normal after optimal medical therapy, and the noncompaction became less prominent. The cause of his reversible cardiomyopathy remains unknown. The progress to noncompaction might be a compensatory mechanism for worsening systolic function. To avoid inappropriate and exaggerated diagnoses, we suggest that the diagnosis of suspected myocardial noncompaction be carefully established by means of imaging.

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