Sick sinus syndrome in cardiac noncompaction

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Introduction
Left ventricular noncompaction cardiomyopathy (LVNC) is a rare genetic disorder characterized by a thick, spongy, noncompacted endocardial layer and a thin compacted epicardial layer.1 The exact etiology is unknown, but it has been deemed as primarily genetic cardiomyopathy by the American Heart Association and as unclassified cardiomyopathy by the European Society of Cardiology.2 LVNC is frequently found to be associated with heart failure, embolism, and ventricular tachycardias.3 However, its association with sinoatrial (SA) nodal dysfunction is rare. In this report, we present the case of a young patient who was found to have sick sinus syndrome with prolonged SA nodal pause of 12 seconds and syncope associated with underlying LVNC.

Case report
A 40-year-old adult Caucasian man with recent ischemic stroke and right-sided hemiparesis on active anticoagulation therapy presented to his cardiologist with progressively worsening symptoms of palpitations and fatigue. His baseline electrocardiogram was normal. Transthoracic echocardiography (TTE) showed normal biventricular global and regional systolic function, absence of valvular heart disease, absence of atrial level shunt, and normal diastolic function. An event monitor was placed and subsequently recorded a 12-second sinus nodal pause while the patient was eating dinner (Figure 1). He fainted during this episode. He was admitted to the hospital for further workup. The patient had no history of arrhythmias, including atrial fibrillation. No clear vagal stimulus was identified. He denied any feelings of nausea or dizziness before the episode and was unable to recall the exact sequence of events afterward. He was a lifelong nonsmoker and denied alcohol use. He denied any cardiac or genetic disease in the family. His vital signs were within normal limits, and physical examination was unremarkable. Electrolytes and cardiac enzyme levels were within normal limits. Electrocardiography showed sinus bradycardia with a heart rate of 53 bpm. Cardiac magnetic resonance imaging (MRI) was performed to better elucidate the patient’s cardiac structure and function. The MRI showed deep intertrabecular recesses in the left ventricular (LV) apical area, with a ratio of noncompacted to compacted trabeculae of 2.6, consistent with LVNC (Figure 2). LV global function was mildly abnormal, with a quantitative ejection fraction (EF) of 50%. No myocardial scar was seen on delayed enhancement imaging. No evidence of active inflammation was seen on T2-weighted imaging. He was referred for dual-chamber pacemaker/implantable cardioverter-defibrillator therapy for treatment of both symptomatic sick sinus syndrome and primary prevention of sudden death. Genetic testing for channelopathies was not performed.

Discussion
LVNC is a rare genetic disorder that has been found to have significant correlation with heart failure, ventricular arrhythmias, and embolic events.3 The association of LVNC with SA nodal dysfunction was previously reported in a 23-year-old female patient who presented with SA nodal dysfunction and eventually required a dual-chamber pacemaker.4 She was eventually noted to have complete loss of SA nodal functioning. Our patient was older and presented with prolonged pause and syncope. This finding highlights an important point of how LVNC may have an

KEY TEACHING POINTS

- Left ventricular noncompaction cardiomyopathy (LVNC) is significantly associated with sick sinus syndrome and may require event monitoring.
- LVNC can be missed on echocardiography and may require cardiac magnetic resonance imaging for diagnosis.
- Patients with sick sinus syndrome may require testing for infiltrative disease if results of routine workup are normal.

KEYWORDS Cardiomyopathy; Noncompaction cardiomyopathy; Sick sinus syndrome; Sinoatrial node dysfunction; Syncope

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age- or time-related effect on SA node with loss of functioning over time. Conduction abnormalities are not uncommon with LVNC. One cohort study reported left bundle branch block and PR-interval prolongation of 19% and 15%, respectively, in a group of 78 LVNC cases with mean EF of 40%.5 Our case had similar worsening of PR interval before the pause episode noted on the event monitor.

Ion channel genes (eg, SCN5A), genes encoding calcium release channels (eg, ryanodine receptor 2), and calcium ion reservoir proteins (eg, calsequestrin 2, which is part of a protein complex that contains ryanodine receptor 2) typically cause diseases affecting the QT interval and catecholaminergic polymorphic ventricular tachycardia (types 1 and 2). Mutations in SCN5A have been reported in Japanese patients with LVNC.6 Similarly, HCN4 gene mutations are found in LVNC and are associated with both structural (LVNC) and rhythm abnormalities, such as atrial fibrillation.7 These genes might also have a role in SA nodal dysfunction. In our case, the patient refused to undergo genetic testing and stated that he would follow up with such testing on an outpatient basis.

Caliskan et al8 reported a 23-year-old male patient with symptomatic sinus nodal dysfunction with moderate aortic regurgitation, severe LV dilation, and LVNC. However, the authors also considered the possibility of pseudo-LVNC pattern secondary to chronic volume overload and severe bradycardia. In our case, the patient did have a mildly low EF of 50%, but he had no symptoms or signs of volume overload. Therefore, it would be safe to presume that LVNC was the primary culprit in causing sick sinus syndrome. The likely reason could be underlying interstitial fibrosis as noted in the

Figure 1  Sinus pause recording on the event monitor.
biopsy specimens from LVNC cases. This would have a broad effect on the overall conduction system. Isolated involvement of the SA node is uncommon and requires additional research in order to determine the exact pathophysiology. Another important point highlighted by our case is that LVNC might not always be diagnosed on TTE, so cardiac MRI should be considered in such cases with high suspicion for LVNC.

**Conclusion**

Young patients who present with sinus nodal dysfunction of unknown etiology should be tested for possible underlying LVNC as a cause. In patients with high suspicion for LVNC in whom TTE is nondiagnostic, cardiac MRI should be used.

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