

Isolated Ventricular Noncompaction

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Isolated ventricular noncompaction (IVNC) of the myocardium is a rare cardiomyopathy resulting from an intrauterine arrest in the normal process of myocardial compaction. The disease is often familial and has recently been categorized in the group of unclassified cardiomyopathies. Echocardiography is the method of choice for the diagnosis of this disease. We describe a case of IVNC in a family in which two adult members (a brother and a sister) were found to be affected by this disease. The diagnosis of the disease was made after a fainting episode of the brother. The echocardiographic examination revealed multiple prominent muscular trabeculations with deep intertrabecular spaces in the left ventricular apex. Using colour flow imaging, communication between the intertrabecular spaces and left ventricular cavity was demonstrated. These findings were pathognomonic for IVNC. The clinical and therapeutic management of these patients is also discussed.

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Isolated ventricular noncompaction (IVNC) of the myocardium is a rare cardiomyopathy resulting from a failure of trabecular compaction of the developing myocardium¹. The disease is often familial, while the most serious clinical manifestations of this disorder are ventricular arrhythmias, heart failure, cardioembolic events and sudden cardiac death. In a recently published report on definition and classification of cardiomyopathies by the World Health Organization, IVNC has been categorized as unclassified cardiomyopathy³. In this paper we describe a case of IVNC in a family, in which two adult members (a brother and a sister) were found to be affected by this disease.

Case report

A 19 year old male soldier was admitted to the Nicosia General Hospital because of an episode of blurred vision and total loss of sensation on the left side of the face and body, which occurred while he was doing some mild exercise. The absent sensation gradually returned over the next two days. On questioning, he men-

tioned three episodes of palpitations during the last two years. Three weeks prior to the transient ischemic attack (TIA) he had fainted whilst climbing down from a guard tower. He injured himself and was unconscious for several minutes.

He had an interesting family history. His mother had fainted on numerous occasions and his seventeen year old sister, experienced several episodes of dizziness and numbness of the left arm. Four brothers of his grandmother had died at a young age from unexplained sudden death.

The patient's 12 lead electrocardiogram (ECG) was normal. Mild cardiomegaly was observed on chest radiography. The results of routine laboratory work and cardiac enzymes were normal. Electroencephalogram, Computerized Tomography (CT) brain scan and Magnetic Resonance Imaging (MRI) brain scan were normal. There were no ST segment changes or arrhythmia on maximal exercise test and 24-hour ambulatory ECG recording (24-h ECG). Late potentials were found in signal-averaged electrocardiogram (QRSd: 123 ms, RMS40: 16 μ V, and LAS40: 30 ms). Echocardiog-



Figure 1. Parasternal short axis view of the left ventricle in a 19 years old patient with IVNC. There is a thin compacted epicardial layer (arrow head) and an extremely thickened endocardial layer with prominent trabeculations and deep recesses (arrow). (LV: left ventricle, RV: right ventricle, SW: septum wall, P/W: posterior-inferior wall).

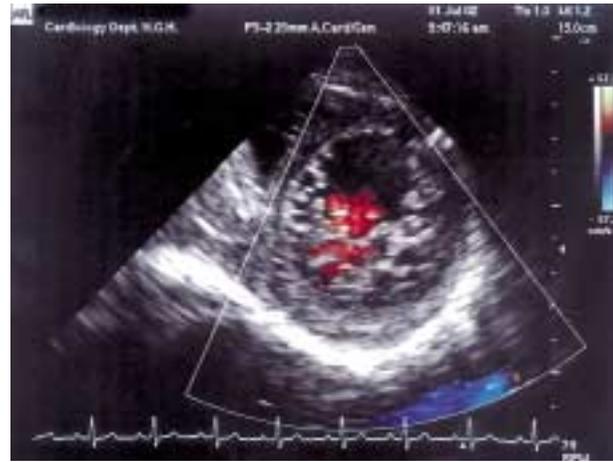


Figure 2. Parasternal short axis view echocardiogram of 19 years old patient with IVNC. With color flow imaging, communication between intertrabecular spaces and left ventricular cavity is demonstrated.

raphy showed normal right and left ventricular cavity dimensions according to body surface area. Ejection fraction was impaired (EF: 45-50%). There were no abnormalities of diastolic function. All cardiac valves appeared normal and there were no findings of any coexisting congenital lesion. The left ventricular wall was thickened and had an inhomogeneous appearance with multiple prominent muscular trabeculations present in the left ventricular apex and mid ventricular wall, with deep recesses penetrating the myocardium (Figure 1). These findings were prominent in the left ventricular inferior and lateral wall. Colour-flow imaging, demonstrated communication between intertrabecular spaces and left ventricular cavity (Figure 2). These findings were compatible with the diagnosis of IVNC. On short axis transthoracic view, the left ventricular myocardial wall was extremely thick with two layers of myocardial wall structure (Figure 1). There was a thin compacted myocardium on the epicardial side (epicardial compacted zone) and an extremely thick noncompacted myocardium on the endocardial side (endocardial compacted zone). The ratio of noncompacted / compacted zone (N/C ratio) was $2,6 / 0,9 = 2,9$. These findings were pathognomonic for IVNC.

A multiplane transesophageal echocardiographic (MTE) examination was also performed. On transgastric view (90°), the left anterior papillary muscle had a peculiar appearance characterized by

the presence of numerous separated bands inserting into the anterior wall near the apex (Figure 3). On multiplane transgastric short-axis view, the myocardium had a spongy appearance, characterized by the presence of numerous separated bands inserted in the inferior and lateral ventricular wall (Figure 4). Deep intertrabecular spaces communicating with the left ventricular cavity were evident by colour flow imaging. Although the presence of clots was excluded in the echocardiographic study, the patient began oral anticoagulation treatment because of the high prevalence of thromboembolic events in this disease. Atenolol (12.5 mg daily) and captopril (12.5 mg, three times daily), were administered to the patient.

As this disease is often familial, the patient's parents and grand parents were also screened echocardiographically to identify asymptomatic patients. No abnormal findings were found. The patient's seventeen year old sister was also examined. She was complaining of episodes of dizziness and numbness of the left arm. The two-dimensional echocardiogram confirmed the diagnosis of IVNC. There were multiple prominent trabeculations with multiple deep intertrabecular recesses at the apex, with the characteristic two-layer structure of the myocardial wall at that level and N/C ratio >2 . The ECG was normal. On 24-h ECG several episodes of supraventricular tachycardia were recorded. The patient was treated with 25mg atenolol daily and oral anticoagulation.



Figure 3. (A): Multiplane transesophageal echocardiographic study. On transgastric two chamber view (90°) the left anterior papillary muscle had a peculiar appearance characterized by the presence of numerous separated bands (arrow) inserting into the anterior wall near the apex. (B): Deep intertrabecular spaces (arrow) communicating with the main left ventricular cavity are noted. (LV: left ventricle, RV: right ventricle, A/W: anterior wall, I/W: middle and apical inferior wall).

Discussion

Noncompaction of ventricular myocardium is an extremely rare disorder. The diagnosis of this disease is not difficult when the cardiologists are aware of this disorder. Echocardiography is the method of choice to diagnose IVNC. The diagnosis is based on the following combined echocardiographic findings²: 1) a two-layer structure of the ventricular myocardial wall consisting of a thin compact epicardial layer and a thick noncompact endocardial layer with prominent trabeculations and deep intertrabecular recesses, 2) continuity between the left ventricular cavity and the deep intertrabecular recesses which are filled with blood from ventricular cavity, 3) ab-

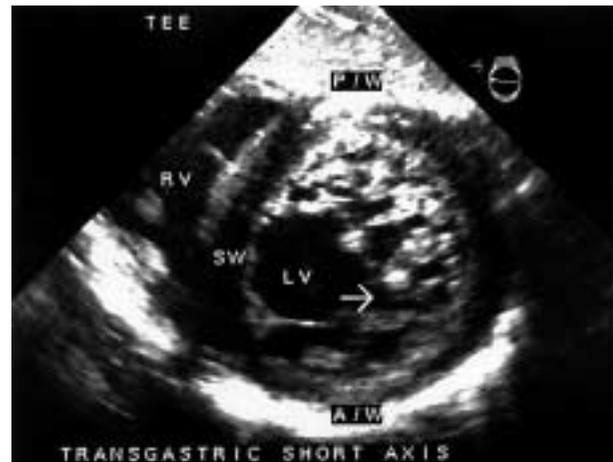


Figure 4. Multiplane transgastric short-axis view of the left ventricle shows prominent left ventricular trabeculations with multiple deep intertrabecular recesses (arrow). (LV: left ventricle, RV: right ventricle, SW: septum wall, P/W: posterior-inferior wall, A/W: anterior wall).

sence of other congenital or acquired heart disease. This last point is crucial to differentiate IVNC from a congenital condition which is characterized by spongy appearance of the left ventricular wall in combination with congenital obstructive lesions of the left and right ventricular outflow tract^{4,6}.

Prominent left ventricular trabeculations have been reported in 68% of normal hearts⁷ and can also be observed in hypertrophic hearts secondary to valvular, hypertrophic or dilated cardiomyopathy⁸. The echocardiographic examination must be performed with special care to avoid false diagnosis of the disease. Apart from the characteristic two layer myocardial wall structure, another useful criterion for proper differential diagnosis is the location of the prominent trabeculations on the left ventricular wall. In the majority of cases the typical morphological features of IVNC are located in the apical and mid-ventricular segments of both the inferior and lateral left ventricular wall, sparing the left ventricular base². Other ventricular segments are rarely affected.

Another useful criterion is the ratio of noncompacted / compacted zone (N/C ratio)². A N/C ratio ≥ 2 is diagnostic for IVNC, since in hearts with prominent trabeculations from other causes, the thickness ratio between non-compacted and compacted zone never reaches the ratio of ≥ 2 .

Although MTE is not the method of choice for the diagnosis of IVNC it has several advantages in comparison with transthoracic echocardiography. In

particular, it facilitates excellent views of the left ventricular walls and offers significant diagnostic help in conditions where the left ventricular cavity is abnormal, such as apical hypertrophic or infiltrative cardiomyopathy and apical thrombus⁹. MTE has a complementary role in the identification of IVNC, particularly in unclear cases and in patients where MRI cannot be performed.

All clinical and echocardiographic findings in this patient were compatible with the diagnosis of IVNC. The trabeculations were most prominent in the middle and apical segments of the inferior and lateral left ventricular wall which are most frequently involved in IVNC. The ejection fraction was moderately reduced in this young patient, mainly due to hypokinesia of non-compacted segments. Depressed left ventricular systolic function was found in 82-86% of patients with IVNC². The reason for progressive heart failure has not yet been elucidated. Ischaemic lesions were documented in histological specimens and restricted myocardial perfusion was demonstrated by positron emission tomography (PET) in prominent trabecular areas in patients with IVNC¹⁰. Relative chronic myocardial ischemia is a possible mechanism of the progressive systolic dysfunction in patients with IVNC¹¹.

The clinical manifestations of IVNC are not specific and include several major complications. The most important clinical manifestations² of this disease are: heart failure 53%, ventricular tachycardia 41%, sudden cardiac death 35%, cardioembolic events 24% and syncope 18%. Ventricular arrhythmias are a major and sometimes fatal complication in patients with IVNC^{1,2}. Ventricular tachycardia has been observed in 41% of patients with IVNC². Other arrhythmias (atrial fibrillation, ventricular premature beats) were also found in patients with IVNC. With the use of signal-averaged electrocardiogram, late low-amplitude potentials were detected in this young patient with IVNC. There is not enough experience in the significance of late potentials in patients with IVNC. According to some authors the presence of late potentials in patients with IVNC is related to the severity and the extent of the disease⁹. We do not feel that the episodes of palpitations in this young patient, represent a sustained ventricular arrhythmia, although the syncopal episode remains unexplained. Arrhythmia was not detected on exercise testing and 24-h ECG. Since there is always the risk of sustained ventricular arrhythmia in patients with IVNC, empirically, a low dose beta blocker

(atenolol 25 mg daily) was given. Both patients will be followed up by 24-h ECG and in case of severe arrhythmia such as ventricular tachycardia an automated internal cardioverter defibrillator (ICD) will be implanted. Sudden arrhythmogenic cardiac death is a potential complication in patients with IVNC. Many authors believe in following an aggressive approach for the management of ventricular arrhythmias and they recommend "early" implantation of an ICD, as an option for reducing the risk of premature death².

Cardioembolic events have been reported in many patients with IVNC. The high prevalence of these events was independent of the left ventricular dimensions and function^{1,10}. The endomyocardial morphology in IVNC predisposes to the development of mural thrombi within the deep intertrabecular spaces. Although CT and MRI brain scan in our patient, were negative for cerebral embolization and infarction, clinical presentation on admission was suggestive of a TIA. Most authors recommend oral anticoagulation for every patient in whom IVNC is diagnosed². For these reasons both our patients were given such therapy.

The prognosis of patients with IVNC range from a prolonged asymptomatic course to a severe cardiac disability, leading to heart transplantation and death. Long-term follow up showed a high incidence of heart transplantation and death. The prognosis is poor and about 50% of adult patients died suddenly². Prognosis is worse in patients with heart failure NYHA class III-IV, left ventricular end-diastolic diameter >60 mm, left bundle branch block and chronic atrial fibrillation. In this group of patients heart transplantation and implantation of ICD may improve the long term survival².

The confirmation of similar echocardiographic findings between brother and sister in this family underlines the familial character of this disease. Both familial^{2,12,13} and sporadic¹ forms of IVNC have been described. Familial form has been observed in 40-50% in pediatric population¹² and in about 18% in adult population² with IVNC. The patterns of inheritance are not well defined. Some authors describe an X-linked inheritance¹⁴ while others support an autosomal dominant inheritance¹⁵.

Conclusions

We described a case of IVNC in a family, in which two adults members (brother and sister) were affect-

ed by this disease. Although a detailed review article about IVNC was published recently by Prappa et al¹⁶, this is the first published case of IVNC in the Greek and Cypriot literature. The diagnosis of this disease was achieved after an episode of TIA in the young patient. The echocardiographic examination, which is the chosen method for the diagnosis of this disease, revealed multiple prominent trabeculations with deep intertrabecular spaces communicating with left ventricular cavity in the middle and apical segments of left ventricle. Since the disease is often familial, the whole family was investigated and the same echocardiographic abnormalities were found in the younger sister of this patient. Echocardiographic screening is recommended in all first-degree relatives of patients with IVNC in order to identify asymptomatic patients who are at high risk from the serious complications of this disease.

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