Familial Left Ventricular Noncompaction
Associated With a Novel Mutation in the Alpha-cardiac Actin Gene

**Miocardiopatía no compactada familiar asociada con una mutación nueva en el gen de la alfa-actina cardiaca**

To the Editor,

Left ventricular noncompaction (LVNC) is characterized by multiple prominent ventricular trabeculations and deep intertrabecular recesses. A familial background is found in 18% to 50% of adults and the estimated prevalence in echocardiographic studies is 0.014% to 1.300%. Its genetic bases are heterogeneous, with only two reported mutations in the alpha-cardiac actin gene (ACTC1): ACTC1M271V and ACTC1E101K with additional apical hypertrophic cardiomyopathy, restrictive filling, and septal defects. As in other inherited familial conditions, the finding of a pathogenic mutation can be very valuable when screening at-risk relatives.

Herein we present a family with LVNC caused by the novel heterozygous ACTC12809T mutation, which exhibited different clinical features and courses in the affected family members, namely isolated LVNC, LVNC associated with atrioseptal defect, and restrictive cardiomyopathy associated with atrioseptal defect.

A 9-month-old girl underwent heart transplantation in another hospital because of a restrictive cardiomyopathy with dilated atria, depressed left ventricular ejection fraction, and an associated small ostium secundum atrioseptal defect (proband, Figure, IV:1). At hospital discharge, the presence of a previously unsuspected LVNC was reported in the macroscopic evaluation of the heart. No histologic evaluation was carried out and no samples from the explanted heart were kept for further examination. A comprehensive workup, approved by the local research ethics committee, was offered to her first-degree relatives and the family tree was accordingly expanded. This evaluation included electrocardiogram, echocardiography, and blood sampling for genetic studies. Cardiac magnetic resonance imaging, exercise testing, and Holter-electrocardiogram were performed at cardiologist discretion. LVNC was defined following Jenni's (telesystolic noncompacted/compacted myocardium > 2 by echocardiography) and/or Petersen's criteria (telediastolic noncompacted/compacted > 2.3 by cardiac magnetic resonance imaging).

Sanger sequencing (MYH7, myosin binding protein C3, Nkx2.5, and ACTC1 genes) was performed in genomic DNA of the maternal

**Figure.** Familial pedigree. ACTC1, alpha-cardiac actin gene; LVNC, left ventricular noncompaction; LVH, left ventricular hypertrabeculation; MI, myocardial infarction; NE, not evaluated; OS-ASD, ostium secundum atrioseptal defect; RCM, restrictive cardiomyopathy. Circles denote females, squares males. Red symbols represent affected individuals. *Macroscopic evaluation at heart transplantation.
<table>
<thead>
<tr>
<th>Pedigree position</th>
<th>Sex/ Age, y</th>
<th>Clinical history</th>
<th>ECG</th>
<th>Echocardiography</th>
<th>CMRI</th>
<th>Holter</th>
<th>Exercise testing</th>
<th>Genetics: heterozygous ACTC1&lt;sup&gt;1289T&lt;/sup&gt; mutation</th>
</tr>
</thead>
<tbody>
<tr>
<td>II:3 F/59</td>
<td>Asymptomatic</td>
<td>Normal</td>
<td>Normal</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Non carrier</td>
</tr>
<tr>
<td>II:4 M/66</td>
<td>Dyspnea, NYHA class I-II/IV</td>
<td>SR, first degree AV block, QS in the inferior leads</td>
<td>One year before this study, in another center: echocardiography within normal limits; At the beginning of this study: LVNC, normal LV size; LVEF, 36%; moderately impaired RVEF</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Carrier</td>
</tr>
<tr>
<td>III:2 F/33</td>
<td>Asymptomatic</td>
<td>Normal</td>
<td>Normal</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Non carrier</td>
</tr>
<tr>
<td>III:4 F/32</td>
<td>Previous clinical history: OS-ASD repaired at 10 years of age; one miscarriage (hydrops)</td>
<td>Normal</td>
<td>Three years before this study, in another center: echocardiography within normal limits; At the beginning of this study: normal LV size; LVEF, 53%; apical and septal hypertrabeculation, restrictive filling pattern normal sized RV with mildly impaired RVEF</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Carrier</td>
</tr>
<tr>
<td>III:5 M/37</td>
<td>Asymptomatic</td>
<td>Normal</td>
<td>Normal</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Non carrier</td>
</tr>
<tr>
<td>III:6 M/31</td>
<td>Dyspnea, NYHA class II/IV</td>
<td>SR, nonspecific ventricular activation delay</td>
<td>LVNC: spheric-shaped dilated LV (65/52 mm); LVEF, 25%; restrictive filling pattern; severe mitral regurgitation; normal-sized RV with preserved RVEF</td>
<td>LVNC; dilated LV; LVEF, 27%; prolapse of posterior mitral left with severe mitral regurgitation.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Ventricular ectopies and 1 nonsustained ventricular tachycardia (3 beats) at peak exercise</td>
</tr>
<tr>
<td>III:5 F/33</td>
<td>Asymptomatic</td>
<td>Normal</td>
<td>Normal</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Non carrier</td>
</tr>
<tr>
<td>IV:1 F/3</td>
<td>Heart transplantation at 9 months of age because of refractory heart failure; no further clinical events</td>
<td>SR at 150 bpm; left atrial and LV hypertrophy and inespecific alteration in the ventricular repolarization</td>
<td>Before heart transplantation: dilated LV (36/27 mm) and LVEF, 46%; restrictive filling pattern; severe-moderate mitral and tricuspid regurgitation; moderate pulmonary hypertension; OS-ASD, 5 mm</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Carrier</td>
</tr>
</tbody>
</table>

ACTC1, alpha-cardiac actin gene; AVB: atrioventricular block; CMRI, cardiac magnetic resonance imaging; ECG, electrocardiogram; F, female; LGE, late gadolinium enhancement; LV, left ventricle; LVEF, left ventricular ejection fraction; LVNC, left ventricular noncompaction; M, male; MI, myocardial infarction; NE, not evaluated; NYHA, New York Heart Association; OS-ASD, ostium secundum atrioseptal defect; RV, right ventricle; RVEF, right ventricular ejection fraction; SR: sinus rhythm.
septal ACTC1I289T mutation important to treat and Polyphen-2, chemical preserved amino acid. ACTC1I289T mutation, its sequences cosegregated with the ACTC1I289T mutation, ACTC1I289T mutation for the study. We acknowledge that a more thorough genetic study could have included many other genes. Nonetheless, we considered it finished in terms of cost-effectiveness for three reasons: a) our results were consistent with a previous study linking LVNC and septal defects due to ACTC1 mutation; b) the variant strongly cosegregated with the genotype, and c) the molecular consequences of the variant were considered probably pathogenic. Further functional information obtained from animal models may be valuable to confirm the causal role of the ACTC1I289T mutation.

In summary, we offer the phenotypical description of a family with LVNC caused by the highly penetrant, novel, heterozygous ACTC1I289T mutation. Remarkably, in the literature this is the third ACTC1 mutation causing LVNC, and associated ostium secundum atrioseptal defect in some affected family members.

Acknowledgements

We thank the patients for taking part in the study and Biobanco La Fe for its technical support (PT13/0010/0026).

FUNDING

This work was supported by the Instituto de Salud Carlos III (PI11/00019, CP09/00065 and RD12/0042/0029), the Generalitat Valenciana (PROMETEO 2011/027), and the Agence Nationale de la Recherche (ANR-13-BSV1-0023-03).

Maria Rodríguez-Serrano, a,b Diana Domingo, a,b,c Begoña Igual, d Ana Cano, c Pilar Medina, d and Esther Zorio e,c

aServicio de Cardiología, Hospital Universitario y Politécnico La Fe, Valencia, Spain
bDepartamento de Medicina, Universidad de Valencia, Valencia, Spain
cGrupo Acreditado en Hemostasia, Trombosis, Arteriosclerosis y Biología Vascular, Instituto de Investigación Sanitaria La Fe, Valencia, Spain
dUnidad de Imagen Cardiaca, ERESA, Valencia, Spain
eSección de Cardiología Pediátrica, Servicio de Pediatría, Hospital Universitario y Politécnico La Fe, Valencia, Spain

*Corresponding author:
E-mail address: zorio_est@gva.es (E. Zorio).

Available online 5 September 2014

REFERENCES


Improvement in Hemodynamics and Contractility With Multipoint Left Ventricular Pacing in Cardiac Resynchronization Therapy

Mejoría hemodinámica y de la contractilidad con la estimulación multipunto del ventrículo izquierdo en la terapia de resincronización cardíaca

To the Editor,

Heart failure is a leading cause of morbidity and mortality in Western countries. Biventricular pacemakers have been used to treat heart failure since the 1990s. Over the last decade, randomized studies2,3 have demonstrated the benefit of cardiac resynchronization therapy (CRT) and helped to establish its indications. This therapy has been shown to increase survival and decrease hospitalizations in patients with heart failure, left ventricular (LV) dysfunction, and prolonged QRS, in particular in those with complete left bundle branch block. Unfortunately, a significant number of patients (30%-40%) have no response to CRT. This lack of response could be explained by inappropriate pacing site selection, suboptimal device programming, or absence of dysynchronous basal LV contraction. Another limitation could be that pacing from a single LV point is incapable of generating a coordinated mechanical activation. Quadrupolar electrodes would allow LV pacing from 2 points far...