Despite the relative infrequency of interaction between a TAVI prosthesis and a PMP, this problem caused 50% of in-hospital complications (excluding conduction disorders) and a significant decrease in TAVI success rate according to VARC-2 criteria; however, in general this complication could be resolved satisfactorily during the intervention.

A clear publication bias exists in this area, and there is therefore a need for larger series and ideally randomized studies to evaluate the best approach to use in this technically challenging patient subgroup. Regardless of this consideration, careful planning of these interventions should include computed tomography and other imaging studies to determine the distance between the prosthesis and the aortic ring ($\geq$ 3 mm for the transapical route and 7 mm for the transfemoral route).[3] Furthermore, intraprocedural transesophageal echocardiography can reduce the risk of this worrisome complication, independently of the specific TAVI approach used.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found in the online version available at: http://dx.doi.org/10.1016/j.rec.2016.09.037.

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Hypertrophic Cardiomyopathy Without Ventricular Hypertrophy: Usefulness of Genetic and Pathological Study in Preventing Sudden Death

Miocardiopatía hipertrófica sin hipertrofia ventricular: utilidad del estudio anatomopatológico y genético en la prevención de la muerte súbita

To the Editor,

Hypertrophic cardiomyopathy (HCM) is diagnosed by the presence of ventricular hypertrophy $\geq$ 15 mm in the absence of any abnormal loading conditions that could cause it, or $\geq$ 13 mm if a relative is known to have HCM. On histological examination, myofibrillar disarray is characteristic of the disease. However, there have been reports of cases of HCM with sudden death (SD) in which the only identified abnormalities were myofibrillar disarray or mutations in the *TNNT2* gene.[1] We present a family with multiple cases of SD, in which pathological examination and genetic study were key in the diagnosis.

The proband was a 28-year-old woman, with no past medical history of note, who died suddenly while getting into her car. Postmortem examination revealed a heart weighing 295 g with a 13-mm interventricular septum. Microscopic examination showed microscopic fiber hypertrophy and isolated foci of myofibrillar disarray (Figure 1B). Family history included 4 maternal aunts of the proband who had SD at the ages of 17 (n = 2), 18, and 30 years (Figure 1A). The proband's 55-year-old mother had a normal echocardiogram and an electrocardiogram (ECG) with repolarization abnormalities in the inferolateral leads. The proband had 3 sisters and 1 brother, with different fathers. One of the sisters, aged 30 years, had a completely normal echocardiogram and cardiac magnetic resonance (CMR) scan, but ECG showed ST depression in the inferolateral leads. Stress echocardiography and coronary angiography showed no abnormalities. The other 2 sisters had normal echocardiograms and ECGs. In the brother, mild left ventricular hypertrophy was observed, with a 16-mm interventricular septum, and the ECG showed abnormalities similar to those of the sister and the mother (Table 1).

Given the suspicion of familial HCM with mild phenotypic expression and the high incidence of SD, a genetic study was performed on a frozen blood sample from the deceased patient. We used a panel that identifies, through next-generation sequencing, multiple genes associated with cardiomyopathies and channelopathies, given the possibility of an underlying channelopathy in the deceased patients. An Arg94Leu mutation was identified in the troponin T gene (*TNNT2*). This mutation was first described in a British family with a high prevalence of premature SD ($<$ 45 years old) and a diagnosis compatible with HCM. The patients had no history of illness, with SD being the first clinical manifestation. Postmortem examination revealed the absence of macroscopic hypertrophy, although histological examination showed diffuse fibrosis and myocyte disarray. In fact, that study was one of the first to establish that mutations in *TNNT2* could be associated with SD even in the absence of overt hypertrophy.[2,3] Two other mutations affecting the same residue have been described (Arg94Cys, Arg94His) and therefore it appears to be a point susceptible to mutations. This would suggest that any change in the amino acid sequence at this point would be poorly-tolerated. The clinical information available on carriers of these mutations agrees with other findings, such as the recently-published observations on the Arg92Gln mutation in several Mallorcan families.[4] Some studies evaluating microscopic examination in carriers of troponin T mutations indicate that these cause less hypertrophy and fibrosis, but more disarray, than other sarcomere mutations. This could be the underlying factor that explains the high risk of arrhythmia.[5]

The genetic study of the rest of the family showed that the mother, 1 sister (and her 2 children), and the brother (and 1 of his daughters) were carriers of the identified mutation. The latest guidelines do not recommend automatic cardioverter-defibrillator implantation for the presence of a single mutation; however, a defibrillator was implanted as prevention in the proband's 2 carrier siblings, aged 33 and 35 years, due to patient preference (no risk factors except family history of SD) (Table 1). The other carriers,

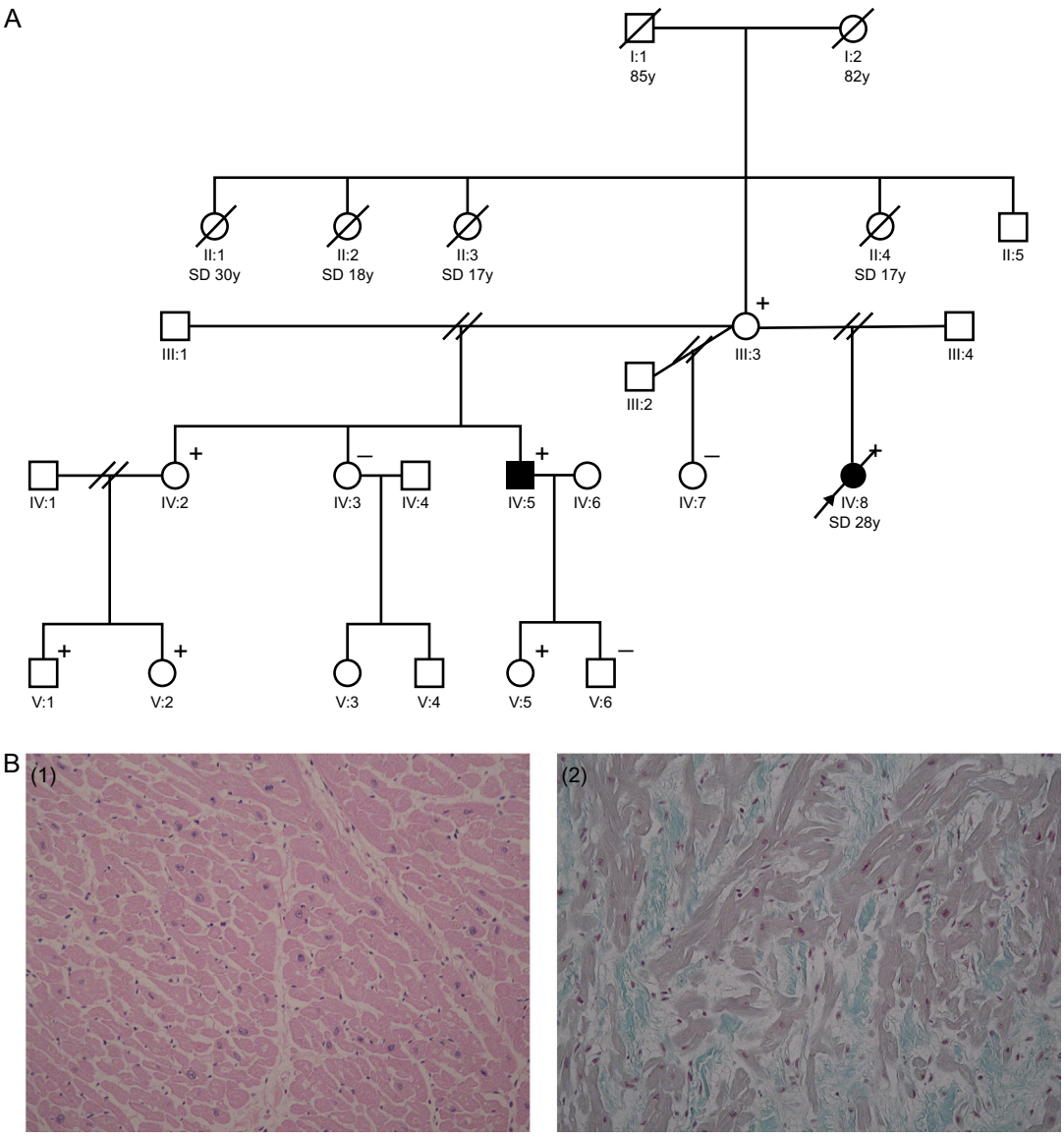

Figure. A: family tree (square, male; circle, female; filled square or circle, phenotypically affected male/female; empty square or circle, healthy male or female; diagonal line, deceased; parallel diagonal lines, divorced). B: histological images of the different cuts taken from the septum and left ventricle o f the proband (IV:8), showing the presence of a congestive cardiomyopathy, with regularly-organized hypertrophic myocytes (left image). Small areas can be seen on the free wall of the left ventricle where the fibers are disordered, lying obliquely and in swirls (disarray) (right image). SD, sudden death; y, years.

Table
Clinical Characteristics of the Carriers of the Arg94Leu Mutation in *TNNT2*

Patient	Sex	Age, y	Arg94Leu mutation in *TNNT2*	Maximum thickness, mm (echo or CMR)	LA size	NSVT on Holter	ECG	Fibrosis on CMR	Events	Treatment
IV:8 (proband)	F	28	+	13	–	–	–		SD	–
III:3	F	55	+	11	38	No	+	No	No	Propranolol
IV:2	F	30	+	10	32	No	+	No	No	ICD, propranolol
IV:5	M	34	+	16	46	No	+	Yes	No	ICD, propranolol
V:1	M	15	+	7	28	No	–	ND	No	Propranolol
V:2	F	13	+	6	20	No	–	ND	No	Propranolol
V:5	F	7	+	5	19	ND	–	ND	No	No

CMR, cardiac magnetic resonance; ECG, electrocardiogram with repolarization abnormalities in the inferolateral leads; echo, echocardiography; F, female; ICD, implantable cardioverter-defibrillator; LA, left atrium; M, male; ND, not done; NSVT, nonsustained ventricular tachycardia.

who are all under 16 except the proband's mother (55 years), are under close follow-up in clinic.

In conclusion, family history, pathological examination, and genetic study are key in the assessment of SD.[6] The information from the family presented here indicates that HCM due to the Arg94Leu mutation in *TNNT2* can present with ECG changes and histological disarray without macroscopic hypertrophy. The risk of SD in carriers is high and therefore risk should be carefully stratified.

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Radiation Exposure to the Pregnant Interventional Cardiologist. Does It Really Pose a Risk to the Fetus?

Exposición de las cardiólogas intervencionistas a radiaciones ionizantes durante el embarazo. ¿Realmente representa un riesgo para el feto?

To the Editor,

Because of concern about the risks posed to the fetus by ionizing radiation exposure during pregnancy, some female cardiologists rule out training as interventional cardiologists. For those already working in this area, pregnancy involves a 1-year interruption (pregnancy and maternity leave) to their careers in interventional cardiology, leading them to delay the decision to become pregnant. This letter describes the spontaneous risk of malformation/cancer in offspring, the increased risk due to radiation exposure, and the recommended dose limits for pregnant employees exposed to ionizing radiation. Little information is available in the literature on pregnant employees exposed to ionizing radiation. Here we present data from 5 interventional cardiologists in Spain who continued to work in catheterization laboratories throughout their pregnancies.

Fetal radiation exposure can lead to 2 types of adverse effects: deterministic (nonprobabilistic) and stochastic (probabilistic). Deterministic effects occur after a threshold dose and include intrauterine growth restriction, miscarriage, mental retardation, low intelligence quotient, and congenital malformations. There is no threshold dose for stochastic effects, although the probability of their occurrence rises as the dose exposure increases. The most significant is childhood cancer.[1] The spontaneous probability of a newborn having a congenital malformation or childhood cancer is 4.07% (Table 1).[1] It is estimated that exposure to 1 mSv during pregnancy would increase this risk by 0.008%, representing a risk of 4.078%, and that exposures of $>$ 10 mSv would increase the risk by 0.1%.[1] Experimental animal studies have shown that doses of $<$ 100 mSv will have no effect on the embryo/fetus[2] in either the preimplantation stage or organogenesis, or the fetal period. However, the question arises of what are the dose levels in interventional cardiology? What dose would be received by the fetus of a pregnant woman working in a catheterization laboratory? It is difficult to find information in the literature, although the doses appear to be extremely low. The Mayo Clinic (Rochester, United States) determined the radiation received by 68 employees (of any profession) who wore an abdominal dosimeter during pregnancy. Of these employees, 56 (82.4%), including 2 interventional cardiologists, had undetectable radiation levels in the abdominal dosimeter under the lead apron.[1] To put these radiation levels into context, it is worth noting that background or cosmic radiation represents an average dose of 0.75 to 1 mSv during pregnancy and, more importantly, there are no differences in the incidence of congenital malformations/miscarriages between pregnant women exposed to doses of $\leq$ 50 mSv and those exposed to background radiation ($<$ 1 mSv). The fetal doses that have been related to the occurrence of malformations/childhood cancer are $>$ 100 to 150 mSv.[1,2] These doses are much higher than those that received by an interventional cardiologist would receive under the apron. As such, if standard protective measures are used, the risk to the fetus would be negligible.

Nevertheless, to guarantee the fetus a similar level of protection to the rest of the population, national and international radiology protection bodies recommend maximum radiation levels during pregnancy that are much lower than those demonstrated to pose a risk to the fetus. To this end, the EURATOM (European Atomic Energy Community treaty) directive sets out a maximum limit of $<$ 1 mSv for the fetus from the time the pregnancy is reported until the birth (2 mSv in dosimeter due to attenuation of abdominal organs).[3] In the United States, a limit of $\leq$ 0.5 mSv/mo has been established, with a total dose during pregnancy of $<$ 5 mSv[1].