Prevalence and Prognostic Role of Right Ventricular Involvement in Stress-Induced Cardiomyopathy

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ABSTRACT

Background: Stress-induced cardiomyopathy (SCM) is a reversible cardiomyopathy observed in patients without significant coronary disease. The aim of this study was to assess the incidence and clinical significance of right ventricular (RV) involvement in SCM.

Methods and Results: We retrospectively analyzed echocardiograms from 40 consecutive patients who presented with SCM at Stanford University Medical Center from September 2000 to November 2010. The primary end point was overall mortality. RV involvement was observed in 20 patients (50%; global RV hypokinesia in 15 patients and focal RV apical akinesia in 5 patients). The independent correlates of RV involvement were older age (odds ratio [OR] 1.09, 95% confidence interval [CI] 1.02−1.7two, $P = .01$) and LVEF (per 10% decrease: OR 3.60, CI 1.77−7.32; $P = .02$). At a mean follow-up of 44 ± 32 months, 12 patients (30%) died (in-hospital death in 3 patients). At multivariate analysis, the presence of an RV fractional area change <35% emerged as an independent predictor of death (OR 3.6, CI 1.06−12.41; $P = .04$).

Conclusions: RV involvement is a common finding in SCM, and may present as either global or focal RV apical involvement. Both older age and lower LVEF are associated with a higher risk of RV involvement, which appears to be a major predictor of death. (*J Cardiac Fail 2015;21:419−425*)

Key Words: Stress cardiomyopathy, echocardiography, right ventricle.

Stress-induced cardiomyopathy (SCM), also known as takotsubo cardiomyopathy, is a reversible disease more commonly observed in postmenopausal women and often triggered by acute emotional or physical stress.[1−3] SCM is characterized by transient wall motion abnormalities of the left ventricle (LV), often with a distinctive apical ballooning pattern, in the absence of significant epicardial coronary artery disease. Although SCM invariably affects the left ventricle, right ventricular (RV) involvement has also been observed.[4−6]

The extent of regional versus global RV involvement in SCM has not been well established. Furthermore, it is unclear whether patients with RV involvement present more often with heart failure (HF) or have worse outcomes. In the present echocardiographic study, we sought to determine (1) the incidence of global versus regional RV dysfunction and its relationship with LV dysfunction, and (2) the prognostic role of RV dysfunction in SCM.

Materials and Methods

Study Design

We retrospectively analyzed 40 consecutive patients who presented with SCM from September 2000 to November 2010 at

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Stanford University Medical Center. The diagnosis of SCM was based on previously described criteria[4]: (1) an acute cardiac event typically presenting with substernal chest pain or shortness of breath, (2) systolic dysfunction with akinesia or hypokinesia of the mid and/or apical left ventricle, (3) electrocardiographic (ECG) changes or cardiac enzyme elevation, (4) the absence of significant atherosclerotic coronary artery stenosis (≤50% luminal narrowing), and (5) prompt normalization of systolic function after presentation. HF symptoms were diagnosed according to current guidelines.[7] All patients were studied with the use of ECG, biomarkers of myocardial damage, echocardiography, and coronary angiography.

Echocardiography

Digitized echocardiographic studies were analyzed by 2 cardiologists (GF and FH) blinded to angiographic and clinical data. Studies were acquired with the use of Hewlett Packard Sonos 5500 or Philips IE 33 ultrasound systems (Philips, Andover, Massachusetts). Acquisitions were performed with the use of a 5 MHz transducer, with a Doppler sweep speed of ≥75 mm/s. All measures were averaged over 3 cycles.

Left ventricular ejection fraction (LVEF) was estimated with the use of the Simpson biplane method of disks. Left ventricular mass was estimated based on a prolate ellipse model of the left ventricle as recommended by the American Society of Echocardiography (ASE) according to the following formula: LV mass = 0.8 × {1.04[(LVIDd + PWTd + SWTd)^3 − (LVIDd)^3]}+ 0.6 g, where LVID is the diastolic LV internal dimension, PWT is the diastolic posterior wall thickness, and SWT is the diastolic septal wall thickness.[8] LV hypertrophy (LVH) was defined as LV mass indexed to body surface area ≥95 g/m^2 in women and ≥115 g/m^2 in men. In measuring LV internal dimension, we avoided the area of ventricular ballooning. Left atrial volume index (LAVI) was calculated with the use of the area-length method in 4-chamber and 2-chamber views. Normal left atrial size was defined as a volume <29 mL/m^2 according to ASE guidelines.[8] Mitral and tricuspid regurgitation severity was assessed according to ASE guidelines.[9] LV filling was assessed by means of pulsed Doppler interrogation at the level of the opened mitral leaflet tips. The pattern of LV filling was classified according to the most recent ASE guidelines.[10,11]

With the use of tissue Doppler imaging (TDI), we measured peak myocardial early diastolic velocity at the lateral mitral annulus and transmitral−to−TDI early diastolic velocity ratio (E/e′).[12]

Tricuspid annular plane systolic excursion (TAPSE) was measured from the systolic excursion of the tricuspid lateral annulus with the use of a 2-dimensional methodology. According to ASE guidelines, RV systolic dysfunction is considered in the presence of TAPSE <16 mm or RV fractional area change (RVFAC) (apical 4-chamber view) <35%.[5] RV involvement

Table 1. Clinical Characteristics of Patients With Stress-Induced Cardiomyopathy

	Total Population (n = 40)
Demographics	
Age, y	70 ± 11
Male sex, n (%)	4 (10)
Comorbidities, n (%)	
Hypertension	32 (80)
Diabetes mellitus	5 (12)
Smoking	17 (42)
Family history of CAD	8 (20)
COPD	9 (22)
Hypothyroidism	10 (25)
Presentation	
Chest pain	21 (52)
NYHA III−IV	15 (37)
Syncope	3 (7)
Other	4 (10)
ECG changes at presentation, n (%)	
STE	15 (37)
STD	1 (2)
Diffuse T-wave inversion	18 (45)
New LBBB	2 (5)
Laboratory values	
Mean peak troponin I (ug/L)	5.1 ± 5.9
Mean peak troponin T (ug/L)	0.67 ± 0.34
Mean peak CK-MB (ng/mL)	18.4 ± 18.5
Medications at discharge, n (%)	
Beta-blocker	23 (57)
Ace-inhibitor	22 (55)
Statin	16 (40)
Outcomes	
In-hospital death, n (%)	3 (7)
Recurrence of SCM, n (%)	1 (2)
Mean follow-up (mo)	44 ± 32
Death at follow-up, n (%)	12 (30)

CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; NYHA, New York Heart Association functional class; STE, ST-segment elevation; STD, ST-segment depression; LBBB, left bundle branch block; SCM, stress cardiomyopathy.

Table 2. Main Echocardiographic Features of Stress Cardiomyopathy (SCM) Patients

	Total Population (n = 40)
IVS (mm)	9.5 ± 1.6
PW (mm)	8.9 ± 1.7
LVEDD (mm)	46 ± 6
LVEDV (mL)	89 ± 29
LVESV (mL)	56 ± 20
LVEF (%)	37 ± 11
LVRP, n (%)	1 (2)
Moderate-severe MR, n (%)	2 (5)
Lateral E′ (cm/s)	6.1 ± 1.9
LAVI (mL/m^2)	32 ± 12
RAVI (mL/m+)	22 ± 8
LV mass/BSA (g/m^2)	83 ± 30
RVEDA (cm^2)	15 ± 4
RVESA (cm+)	9 ± 3
RV length (mm)	71 ± 8
RV base (mm)	33 ± 7
RV mid (mm)	22 ± 6
RV apical (mm)	13 ± 4
RVFAC (%)	40 ± 11
RVFAC <35%	13 (32)
TAPSE mm	16 ± 4
TAPSE <16 mm	12 (30)
RV involvement, n (%)	20 (50)
RV apical akinesia, n (%)	15 (37)
RVSP (mm Hg)	41 ± 8

IVS, interventricular septum; PW, posterior wall; LVEDD, left ventricular end-diastolic diameter; LVEDV, left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; LVEF, left ventricular ejection fraction; LVRP, left ventricular restrictive pattern; MR, mitral regurgitation; LAVI, left atrial volume index; RAVI, right atrial volume index; LV, left ventricle; BSA, body surface area; RVEDA, right ventricular end-diastolic area; RVESA, right ventricular end-systolic area; RV, right ventricle; RVFAC, right ventricular fractional area change; TAPSE, tricuspid annular plane systolic excursion; RVSP, right ventricular systolic pressure.