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Clinical Investigation

Reduction of Left Ventricular Dilation Beyond the First Year After Anterior Myocardial Infarction

JAUME FIGUERAS, MD, JORDI BAÑERAS, MD, SANTIAGO AGUADÉ, MD, ANTONIA SAMBOLA, MD, JOSÉ A. BARRABÉS, MD, JAUME CANDELL-RIERA, MD, ANDREU PORTA-SANCHEZ, MD, AND DAVID GARCIA-DORADO, MD

Barcelona, Spain

ABSTRACT

Background: Reduction of left ventricular (LV) dilation (RD) beyond the first year after ST-segment−elevation myocardial infarction (STEMI) is unknown. We investigated its potential occurrence in comparison with stationary (SD) and progressive (PD) dilation.

Methods and Results: Perfusion gated SPECT features at 1 and 3 years were evaluated in 168 3-year survivors of a first anterior STEMI. Comparisons were made among patients with RD (≥15% reduction of LV end-systolic volume [LVESV]), SD (<15% reduction or increase), and PD (≥15% increase). There were 35 patients with RD (21%), 84 with SD (50%), and 49 with PD (29%). At 1 year, ejection fraction, wall motion and perfusion scores, and LV volumes were similar. In RD patients, the fall in LVESV, nearly 22%, was apparent in those with frank (>51 mL; $P < .001$) or little/moderate LV dilation at 1 year (LVESV ≤51 mL; $P = .002$) and was associated with increased ejection fraction (*P* values .008 and .009, respectively). In the 3 groups, however, LVESV changes were unrelated to 1-year LV volumes, ejection fraction, or contractility score.

Conclusions: At 3 years following anterior STEMI there is reduction of LV dilation in about 21% of patients associated with increases in ejection fraction in those with or without clearly dilated ventricles at 1year. These findings add to the complexity of LV remodeling and possibly suggest very late changes in infarct size. (*J Cardiac Fail 2019;25:645−653*)

Left ventricular (LV) dilation after ST-segment−elevation myocardial infarction (STEMI) is generally progressive (PD)[1−3] and is associated with an increased incidence of heart failure and mortality.[1,4,5] In some instances, however, it may stabilize (SD)[1,3] or reduce (RD) within the first months,[3] probably as a result of a reduction in infarct size.[6,7] It is unclear, however, whether this different evolution may also take place after the first year.

We hypothesized that in view of its underlying mechanisms, development of late RD—beyond 1 year—would probably be unlikely. Therefore, our objective was to investigate the course of LV volumes toward RD, SD, or PD beyond the first year. To this effect, 1-year survivors of a first anterior STEMI were prospectively recruited. They underwent a myocardial perfusion gated single-photon emission computerized tomography (SPECT) at 1 and 3 years, and according to LV volume changes at 3 years they were potentially assigned to 3 groups: RD, SD, and PD. We analyzed whether this different evolution could be linked to differences in clinical and electrocardiographic profiles at index hospitalization, and/or to differences in LV volumes, ejection fraction, and myocardial perfusion or regional wall motion at 1 year.

Methods

Patient Population

From January 2004 to June 2010, 1112 STEMI patients were admitted to our hospital and 298 of them had a first anterior infarction. After excluding those with a first anterior STEMI who died or presented reinfarction during the first year, there were 243 to whom the study was proposed. Six refused to participate, and the remaining 237 were included. They underwent

From the Unitat Coronària, Servei de Cardiologia and Servei de Medicina Nuclear, Hospital Universitari Vall d'Hebron, Barcelona, Spain.

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Reprint requests: Jaume Figueras, M.D., Unitat Coronària, Hospital Universitari Vall d'Hebron, P. Vall d'Hebron 119−129, 08035 Barcelona, Spain. E-mail: 5751jfb@gmail.com

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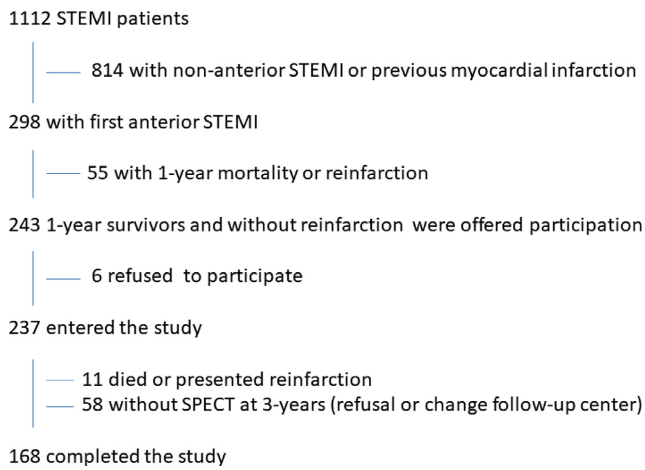

Fig. 1. Patient selection.

gated SPECT at 1 year and were scheduled for another at 3 years. Inclusion criteria were: chest pain >30 minutes associated with ST-segment elevation (STE) ≥0.1 mV in ≥2 adjacent anterior leads, increased myocardial necrosis markers, and lack of associated cardiac diseases. Several conditions, however, prevented performance of the 3-year gated SPECT in 69 patients (death, reinfarction, patient refusal, or change of follow-up center), so the study finally included 168 patients (Fig. 1).

Protocol

Standard 12-lead electrocardiography (ECG) was obtained on admission and daily thereafter during at least the first 3 days. STE was measured at 0.08 seconds after the J-point and reported as sum of STE in the different leads and maximum STE in a single lead. Plasma troponin I (TnI) was measured every 4−6 hours for at least 24 hours. Coronary angiography was performed within the first 24 hours, was visually interpreted by consensus of 2 experienced observers, and patency of the infarct-related artery was reported according to the Thrombolysis in Myocardial Infarction classification. The protocol complied with the Declaration of Helsinki and approved by the Hospital Vall d'Hebron Ethics Committee, and informed consents were obtained from all patients before they entered the study.

Management and Follow-Up

Most patients received reperfusion therapy with either primary percutaneous coronary intervention (PCI) or thrombolysis. Aspirin and intravenous nitroglycerin were routinely administered, whereas IIb/IIIa glycoprotein inhibitors, sodium heparin, and clopidogrel were given to most patients submitted to primary PCI. Beta-blockers and angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blockers were also given, particularly in the presence of heart failure or reduced ejection fraction (EF).

Follow-up treatment included aspirin, statins, beta-blockers, and ACE inhibitors or angiotensin II receptor blockers. In patients with heart failure or reduced EF, aldosterone receptor blockers were also recommended. Analysis of the clinical outcome included the incidence of total and cardiac mortality, nonfatal myocardial infarction, and hospital readmission for heart failure. Death was considered to be of cardiac origin when it occurred suddenly or when it was related to myocardial infarction or heart failure.

Myocardial Perfusion

Patients were studied using symptom-limited treadmill exercise stress test aiming at heart rate >80% of the predicted, occurrence of angina or horizontal/down sloping ST-segment depression. A first dose of 370 MBq of 99m-technicium−tetrofosmin was given 30−60 seconds before finishing exercise, and a second dose of 900 MBq was administered at rest after a >45-minute interval. Images were acquired after 30−60 minutes in a dual-head 90° gamma camera (Siemens E cam, GE Infinia HK4), and slices were reconstructed with the use of filtered back-projection. Myocardial uptake was assessed by consensus of 3 observers blinded to the patient's charts, and a semiquantitative analysis was performed. Five segments were evaluated: anterior, apical, septal, inferior, and lateral.[8] The uptake in each was assessed in stress and rest studies as normal, 0; mild perfusion defect, 1; moderate, 2; or severe, 3; and the sum of all segments, a perfusion score, indicated the extent of ischemia as 0−20. Perfusion score at rest was equated to the score of myocardial necrosis. This scoring system was initiated before publication of the standard scoring methods of the American Society of Nuclear Cardiology[9] and was kept for several years thereafter.[8] Calculation of EF and LV volumes was automatically performed. Endocardial and epicardial boundaries were automatically traced with the use of the quantitative QGS software (Cedars-Sinai Medical Center, Los Angeles, California), and no corrections were made for attenuation and scatter in the image reconstruction.

The reproducibility of automated LV volume and EF measurements was analyzed in 2 resting gated SPECTs of 55 patients with diagnosed or suspected coronary artery disease (average age 61 years, 74% male). It revealed the following variabilities and coefficients of correlations: (a) LVESV: 0.5 ± 5.4 mL and 0.99 (95% confidence interval [CI] 0.99−1.0), respectively; (b) LVEDV: 1.9 ± 10.7 mL and 0.98 (0.97−0.99); and (c) EF: 0.5 ± 2.6% and 0.99 (0.98−0.90).[10] Three patterns of LVESV evolution were recognized: RD, a ≥15% reduction in the 3-year gated SPECT; SD, a <15% reduction or increase; and PD, a ≥15% increase. Wall motion also was analyzed in the 1-year gated SPECT, this time in a 17-segment distribution: 6 basal, 6 middle, 4 distal, and 1 apical.[9] In a semiquantitative evaluation, normal wall motion was identified as 0, mild hypokinesia as 1, moderate hypokinesia as 2, severe hypokinesia as 3, akinesia as 4, and dyskinesia as 5. Wall motion score was the sum of all segments.

Two-Dimensional Echocardiography

In 2-dimensional echocardiography performed at 1 year, we evaluated the existence of mitral regurgitation by means of a semiquantitative estimate with the use of Doppler flow mapping (pulsed or color) and was judged to be mild, moderate, or severe when the regurgitant jet occupied 5%−19%, 20%−39%, or ≥40%, respectively, of the left atrial area.

Statistical Analysis

We compared the clinical, electrocardiographic, angiographic, and SPECT variables among the 3 groups (RD, SD, and PD) at 1 and 3 years. We also compared LV volumes and EF at 1 year with those of a control group without LV dysfunction to define LV dilation. We used the Kolmogorov-Smirnov test to assess normality. The Student *t* test was used for comparison of 2 groups of continuous variables with normal distribution, the Mann-Whitney *U* test for variables with nonnormal distribution, and the chi-square or Fisher exact test for categoric variables. According to the distribution of the variables, analysis of variance, Kruskal-Wallis, or chi-square tests were performed to compare the 3 groups. Post hoc analyses were done with the use of a Bonferroni correction when the overall *P* value was significant. A multivariable logistic regression analysis identified the predictive value of variables associated with PD or RD. Long-term clinical outcome (total mortality) was assessed with the use of Kaplan-Meier curves (log-rank test). The analysis was performed with the use of SPSS 15.0 and the data expressed as mean ± SD, median (interquartile range [IQR]), or n (%).

Results

Clinical, Electrocardiographic, and Angiographic Data

There were 35 (21%) patients with RD, 84 (50%) with SD, and 49 (29%) with PD. The 3 groups showed comparable TnI levels, but history of arterial hypertension was more frequent in the RD group. The number of Q waves in the inferolateral leads in the ECG at 48 hours was higher in the PD than in the RD group, whereas the sum of STE and number of leads with STE were higher in the PD than in the other groups. Moreover, the maximum STE in the inferolateral leads was also higher in the PD than in the other groups (Table 1). The extent of coronary artery disease was similar in the 3 groups and there were no relevant events in the 3 groups between years 1 and 3 (mainly hospital admission for heart failure).

Gated SPECT and Echocardiographic Findings: Predictors of PD and RD

In the gated SPECT at 1 year, the 3 groups showed similar perfusion scores at rest and during stress, as well as similar EF, LVESV, and LVEDV (Table 1). Importantly, individual values of LV volumes varied remarkably in the 3 groups (Fig. 2), and in most patients (n = 162; 96%) LVESV was greater than in a reference group of patients with suspected coronary artery disease, a negative stress test, and a normal LV function (n = 2004; mean 22.5 mL preexercise value), in 144 (86%) it was >37.1 mL (mean >22.5 ± 1), and in 126 (75%) it was >51.7 mL (mean >22.5 ± 2).

In the gated SPECT at 3 years, the perfusion score at rest tended to be lower in the RD than in the other 2 groups and these differences became significant during the exercise stress test. Also, the EF at rest was lower in the PD than in the other 2 groups (Table 1). Of interest, in RD patients the decrement in LVESV was 19.1 ± 10.9 mL (*P* < .001), nearly 22%. Moreover, RD patients with a nondilated or modestly dilated LV at 1 year (LVESV ≤51.7, reference group + 2SD) as well as those with a clearly dilated LV (LVESV >51.7 mL) showed significant increases in EF at 3 years (*P* values .008 and .009, respectively) whereas the latter decreased in the PD group (*P* = .001; Fig. 3).

The wall motion score at 1 year, measured in 148 patients (88%), and the number of segments involved were similar in the 3 groups (Table 1). Also, the 5 segments with worse wall motion score (≥1.6) were the same in the 3 groups (basal anteroseptal, medium anteroseptal, distal anterior, distal septal, and apical).

The incidence of moderate to severe mitral regurgitation at 1 year as assessed with the use of echocardiography in 159 patients (95%), was higher in the PD (n = 11/48; 23%) than in the SD (n = 7/80; 9%) or the RD (n = 3/31; 10%) group (*P* = .043), or the SD and RD groups pooled (n = 10/111; 9%; *P* = .023).

A multivariable regression analysis that included history of arterial hypertension, maximum STE (anterior and inferolateral leads), sum of STE and number of leads with STE at 48 hours, peak TnI, EF, LVEDV, LVESV, and moderate to severe mitral regurgitation at 1 year disclosed that maximum STE in inferolateral leads at 48 hours (adjusted odds ratio [AOR] 2.42, 95% CI 1.34−4.38; *P* = .004) was the only significant independent predictor of PD, whereas the number of leads with STE at 48 hours (AOR 0.81, 95% CI 0.66−0.99; *P* = .042) and the presence of history of arterial hypertension (AOR 2.79, 95% CI 1.27−6.17; *P* = .011) were variables significantly associated with RD.

Management and Follow-Up Events

At index hospitalization, the 3 groups were similarly treated (reperfusion therapy and the rest of medical treatment). Follow-up was available in all patients with a median of 86 months (IQR 31−140). Medical management at 1 and 3 years was also similar in the 3 groups (Table 2). Total mortality rate, however, was higher in the PD than in the other 2 groups (12 [24.5%] vs 12 [10.0%]; *P* = .027; Kaplan-Meier survival curve, log-rank test: *P* = .034). The cause of death could be assessed in 19 patients (79%) and was cardiac in 6 (32%): 4/12 (33%) in the PD group and 2/10 (20%) in the RD and SD groups. Incidence of myocardial infarction or hospital readmission for heart failure was similar in the three groups (Table 2).

Patients Not Included

The clinical, electrocardiographic, and angiographic profile of the 69 patients excluded from the analysis was similar to that of those included, but peak TnI and myocardial perfusion score were significantly smaller, EF was higher, and LV volumes were lower. However, during a long follow-up, although shorter than that of patients included, total and cardiac mortality were similar (Table 3).

Table 1. Clinical, Electrocardiographic, Angiographic, and Gated SPECT Data of 168 Patients With First Anterior STEMI With Reduction, Stabilization, or Progression of LV Dilation at 3 Years According to LVESV at 1year (Mean ± SD, Median, 25−75, or %)

Data	Reduction (A; n = 35)	Stabilization (B; n = 84)	Progression (C; n = 49)	*P* Value			
					A vs B	A vs C	B vs C*
Admission data							
Age, y	59.9 ± 11.3	60.6 ± 12.0	59.0 ± 12.5	.724			
Body surface area, m^3	1.90 ± 0.19	1.88 ± 0.19	1.88 ± 0.20	.831			
Female	5 (14%)	9 (11%)	7 (14%)	.783			
Hypertension	21 (60%)	32 (38%)	18 (37%)	.043	.042*	.047	1.0
Diabetes mellitus	8 (23%)	16 (19%)	12 (25%)	.702			
Smoking				.958			
Active	20 (58%)	45 (54%)	25 (52%)				
Past	6 (17%)	17 (20%)	9 (19%)				
Peripheral vascular disease	5 (14%)	14 (17%)	5 (10%)	.328			
TnI, µg/L	56 (29−157)	78 (44−176)	112 (42−254)	.060			
Heart rate, beats/min	84 ± 19	85 ± 19	81 ± 21	.405			
Blood pressure, mm Hg							
Systolic	132 ± 28	131 ± 29	133 ± 30	.760			
Diastolic	78 ± 17	79 ± 16	77 ± 18	.605			
48-h ECG							
Leads with Q waves	3.0 ± 1.7	3.8 ± 2.1	3.5 ± 2.7	.268			
Inferolateral leads with Q waves	0.6 ± 0.8	1.03 ± 1.3	1.5 ± 1.6	.020	.072	.003	.067
∑STE, mm	3.7 ± 2.9	4.6 ± 4.0	6.1 ± 4.0	.019	.231	.003	.039
Leads with STE	3.0 ± 1.7	3.4 ± 1.8	4.3 ± 2.4	.010	.264	.007	.016
Max STE anterior leads, mm	2.5 ± 1.4	2.8 ± 1.2	2.8 ± 1.3	.607			
Max STE inferolateral leads, mm	0.25 ± 0.46	0.31 ± 0.62	0.63 ± 0.61	.005	.607	.003	.005
No. of vessels with ≥70% stenosis	(n = 25)	(n = 68)	(n = 46)	.244			
0	0	2 (3%)	3 (8%)				
1	20 (67%)	51 (72%)	28 (70%)				
2	6 (20%)	11 (15%)	7 (18%)				
3	4 (13%)	6 (8%)	0				
Left main	0	1 (1%)	2 (5%)				
SPECT data at 1 and 3 years							
Months between gated SPECTs at 1 and 3 years	22.4 ± 13.8	18.5 ± 9.2	19.5 ± 9.2	.174			
Heart rate at 1 year, beats/min	63 ± 13	64 ± 11	68 ± 13	.230			
Blood pressure at 1 year, mm Hg (mean ± SD)							
Systolic	123 ± 16	122 ± 21	120 ± 18	.542			
Diastolic	71 ± 15	74 ± 17	72 ± 16	.620			
Stress heart rate, beats/min							
1 year	124 ± 19	131 ± 19	124 ± 18	.071			
3 years	131 ± 22	129 ± 20	127 ± 20	.765			
Segments with severe transmural perfusion defect in SPECT at 1 year at rest (score 3 of 0−3)	(n = 33)	(n = 81)	(n = 48)	.335			
0	15 (46%)	29 (36%)	14 (29%)				
1 or 2	9 (26%)	33 (41%)	18 (38%)				
3 to 5	9 (28%)	19 (23%)	16 (33%)				
Resting perfusion score							
1 year	10.8 ± 3.6	11.1 ± 3.3	11.4 ± 3.8	.647			
3 years	9.8 ± 3.5	11.1 ± 3.4	11.8 ± 3.5	.069			
Stress perfusion score							
1 year	11.8 ± 3.6	11.8 ± 3.4	12.7 ± 3.4	.324			
3 years	10.4 ± 3.8	12.1 ± 3.3	12.5 ± 3.2	.033	.016	.002	.497
Ischemic score							
1 year	0.9 ± 2.0	0.8 ± 1.8	1.2 ± 1.7	.436			
3 years	0.6 ± 2.1	1.0 ± 2.4	0.8 ± 1.2	.594			
SPECT at 1 year regional wall motion	(n = 30)	(n = 72)	(n = 46)				
Total score	18.3 ± 14.8	22.4 ± 14.3	21.0 ± 8.0	.478			
No. of segments with score ≥1	7.8 ± 4.7	8.7 ± 4.6	8.0 ± 5.2	.506			
EF, %							
1 year	41.7 ± 11.8	41.4 ± 11.2	44.8 ± 15.6	.306			
3 years	47.0 ± 14.2	42.7 ± 11.5	37.8 ± 13.3	.005	.086	.003	.027
LVEDV, mL							
1 year	139.9 ± 65.4	139.1 ± 48.0	140.6 ± 63.2	.988			
3 years	118.7 ± 55.8	142.0 ± 48.4	178.7 ± 88.0	<.001	.024	<.001	.002
LVESV, mL							
1 year	87.4 ± 62.5	85.0 ± 40.8	84.5 ± 54.0	.961			
3 years	68.6 ± 53.9	85.8 ± 40.1	120.5 ± 77.1	<.001	.047	<.001	<.001
LVESV at 1 year >22.5 mL (ref. group)	35 (100%)	83 (99%)	44 (90%)	.843			
LVESV at 1 year >37.1 mL (ref. group + 1SD)	32 (92%)	73 (87%)	38 (79%)	.667			
LVESV at 1 year >51.7 mL (ref. group + 2SD)	27 (77%)	67 (80%)	32 (65%)	.456			

Values are presented as mean ± SD, n (%), or median (interquartile range). EF, ejection fraction; LVEDV, left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; STE, ST-segment elevation; ∑STE, sum of segments with STE; TIMI, Thrombolysis in Myocardial Infarction; TnI, troponin I.

*Post hoc analysis (Bonferroni) for measures that showed a statistically significant difference.

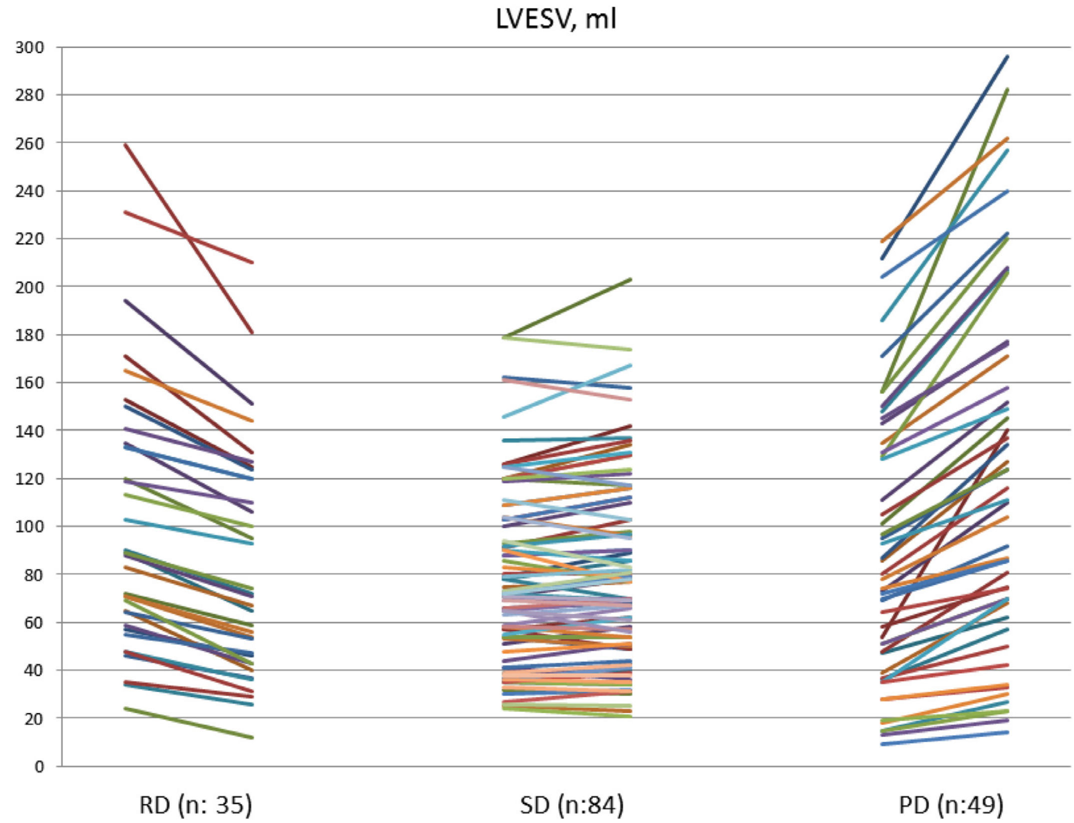

Fig. 2. Wide range of individual values of LVESV at 1 and at 3 years in the RD, SD, and PD groups.

Discussion

This investigation provides the novel information of (a) the existence of a different course of LV volumes (RD, SD, and PD) beyond the first year among patients with a first anterior STEMI and in particular, the occurrence of a "late" RD in 21% of them with a 22% reduction in LVESV at 3 years associated with a significant increase in EF, and (b) the lack of relationship between this variable evolution and the status of 1-year LV volumes, myocardial perfusion or wall motion scores, or site of the segments most severely involved.

LV Remodeling Within the First 12 Months

In STEMI patients adverse remodeling has been observed within the first 6 months according to LVEDV ≥20%[11–13] or LVESV ≥15% criteria.[14–17] It was initially thought that LV dilation was mainly a progressive process,[4,5] but some investigators have shown that, at least within the first months, it may stabilize.[3,18] Moreover, a few reports have recently documented that there may be also a reduction of LV volumes within the first 6 months, a phenomenon called reverse remodeling and defined as a ≥10% reduction in LVESV.[19–21]

Progression, Reduction, and Stabilization of LV Dilation Beyond the First Year

To our knowledge there are no previous prospective investigations on the evolution of LV volumes beyond the first year in patients with a first anterior STEMI, although a few studies have analyzed, retrospectively and in a reduced number of patients, their course during >2 years, with different results.[1,22,23] Gaudron et al, using radionuclide left ventriculography at 3 years in 70 patients, observed no LV dilation in 54%, limited dilation in 26%, and progressive dilation in 20%.[1] However, only 31 had anterior infarction and LV dilation was based on a >8% rather than ≥20% increase in LVEDV.[1] Petersen et al documented a modest increase in LV volumes from discharge to 7 years of follow-up in 55 patients but failed to see different courses of LV remodeling,[22] whereas Springelin et al, using magnetic resonance at 5 years in 25 STEMI patients, disclosed no LV dilation in 32%, limited dilation in 32%, and progressive dilation in 36%.[23] More recently, Hassel et al have shown that among 155 STEMI patients, those who developed larger LVESV according to magnetic resonance imaging at 2 years presented a fall in EF and less wall thickening in the remote zones than those with improvement in EF.[24] In these studies, there were no intermediate LV volume evaluations between the subacute phase and follow-up and, importantly, the authors did not identify patients with reduction of LV dilation.[22–24] Regrettably, the mechanisms to account for the "late" reduction found in our study are not apparent. In fact, the possibility to recover stunned or hibernating myocardium beyond the first year seems very remote, although not impossible.[25] Indeed, in previous series resorption of infarction could be detected by magnetic resonance at 8[11] or 14[26] months, and in our study RD patients also showed a trend toward lower necrosis score at 36 months than at 12 months. An additional explanation could be a more effective afterload

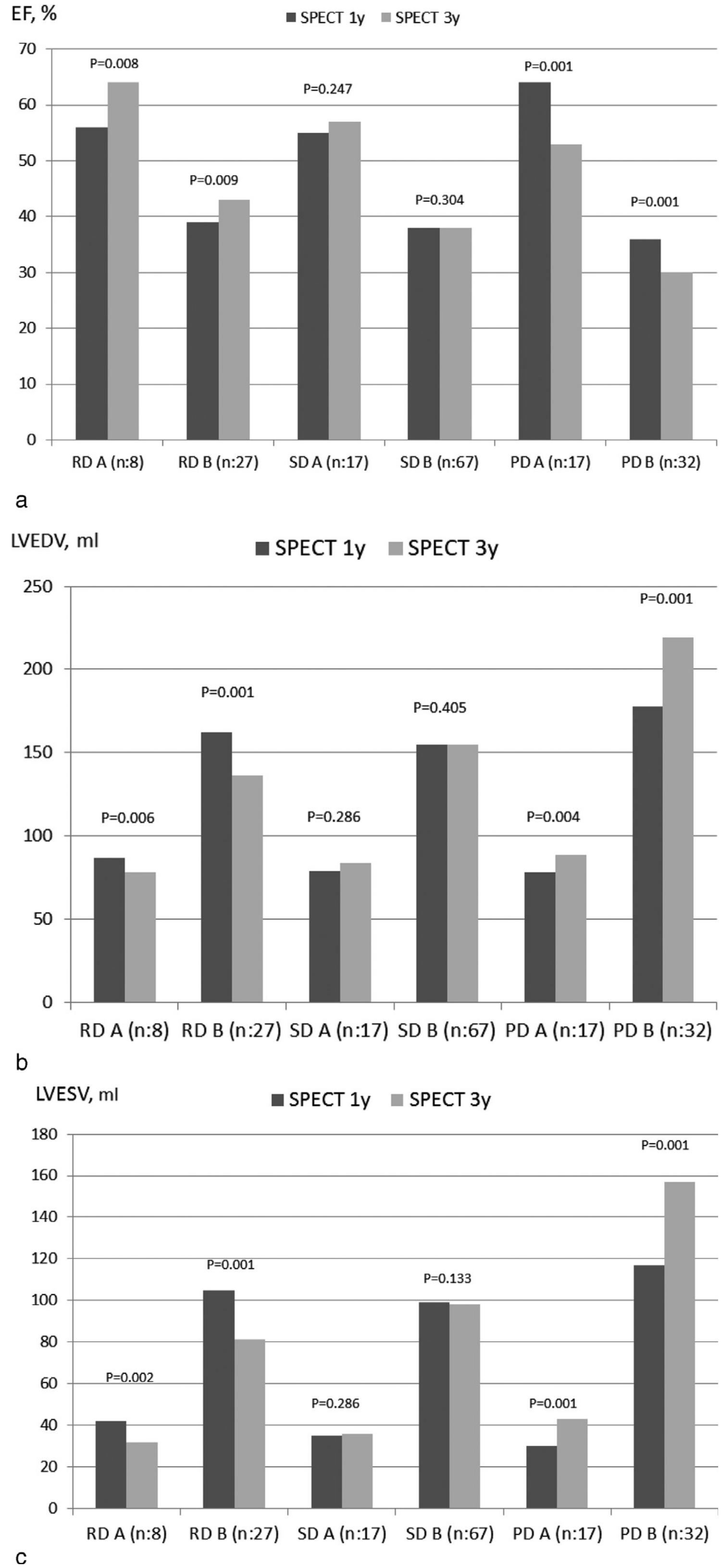

Fig. 3. Comparison of (a) EF, (b) LVEDV, and (b) LVESV between the SPECTs performed at 1 (1y, *black*) and 3 (3y, *gray*) years in the different groups (RD, SD, and PD) in subjects in whom LVESV at 1 year was ≤51 mL (subset A) or >51 mL (subset B).

reduction in the RD than in the other groups, but this is, in part, contravened by the similar use of ACE inhibitors and beta-blockers in the 3 groups.

We also documented that EF and LV volumes at 1 year were not significantly related to their evolution during the ensuing 2 years. Indeed, the wide range of individual

Table 2. Reperfusion Therapy and Treatment During Index Hospitalization as Well as Follow-Up Treatment and Events in Patients With Reduction, Stabilization, or Progression of LV Dilation (Mean ± SD or %)

Data	Reduction (n = 35)	Stabilization (n = 84)	Progression (n = 49)	*P* Value
Admission data				
Reperfusion therapy	29 (83%)	74 (88%)	40 (82%)	.847
Thrombolysis	9 (25%)	18 (21%)	12 (25%)	
rescue PCI	5 (14%)	6 (7%)	6 (12%)	
Primary PCI	20 (57%)	56 (67%)	28 (57%)	
TIMI flow post 0-I	1 (5%)	0	0	
Pain onset to thrombolysis or primary PCI ≤12 h, min	252 ± 176	238 ± 149	281 ± 193	.408
Late PCI	5 (14%)	10 (12%)	6 (13%)	.880
ACE inhibitors/ARBs	26 (74%)	60 (71%)	34 (70%)	.804
Beta blockers	30 (85%)	76 (90%)	43 (88%)	.522
Aldosterone receptor antagonists	3 (9%)	5 (6)	5 (10%)	.515
Aspirin	34 (96%)	81 (97%)	48 (98%)	1.00
Clopidogrel	30 (85%)	71 (85%)	38 (80%)	.302
Heparin	16 (46%)	29 (35%)	22 (45%)	.298
IIb/IIIa glycoprotein inhibitors	22 (63%)	59 (70%)	28 (57%)	.225
Nitrates	34 (96%)	79 (94%)	49(100)	.302
Calcium antagonists	2 (6%)	2 (2%)	3 (6)	.398
Statins	25 (70%)	66 (79%)	33 (68%)	.490
Follow-up data, 1 year				
ACE inhibitors/ARBs	29 (83%)	70 (83%)	37 (76%)	.510
Beta blockers	30 (85%)	69 (93%)	42 (86%)	.460
Diuretics	8 (23%)	15 (18%)	12 (29%)	.322
Aldosterone receptor antagonists	4 (11%)	9 (11%)	6 (13%)	.776
Aspirin	35 (97%)	76 (90%)	44 (90%)	.680
Clopidogrel	28 (80%)	69 (82%)	38 (80%)	.835
Nitrates	6 (17%)	16 (19%)	8 (16%)	.655
Calcium antagonists	5 (14%)	15 (18%)	2 (4%)	.095
Statins	33 (92%)	80 (95%)	46 (94%)	.750
Oral anticoagulants	4 (11%)	5 (6%)	3 (6%)	.470
Follow-up data, 3 years				
ACE inhibitors/ARBs	27 (75%)	68 (81%)	35 (73%)	.529
Beta blockers	31 (86%)	66 (79%)	41 (85%)	.480
Diuretics	7 (19%)	14 (17%)	12 (29%)	.229
Aldosterone receptor antagonists	5 (14%)	9 (11%)	6 (13%)	.876
Aspirin	35 (97%)	74 (88%)	42 (88%)	.256
Clopidogrel	3 (8%)	14 (17%)	5 (10%)	.375
Nitrates	3 (8%)	14 (17%)	5 (10%)	.375
Calcium antagonists	6 (16%)	15 (18%)	2 (4%)	.075
Statins	33 (92%)	80 (95%)	44 (92%)	.645
Oral anticoagulants	4 (11%)	4 (5%)	3 (6%)	.434
Events after the 3-year SPECT				
Admission for heart failure	2 (6%)	3 (4%)	4 (8%)	.560
PCI	2 (6%)	7 (8%)	1 (2%)	.334
NYHA ≥2 or admission for heart failure	4 (11%)	10 (12%)	10 (20%)	.320
Implantable cardioverter-defibrillator	2 (6%)	4 (5%)	2 (4%)	.570
Nonfatal MI	1 (3%)	2 (2%)	3 (6%)	.494
Survival time, mo	89.0 ± 17.9	86.4 ± 24.0	82.0 ± 22.2	.356
Death	3 (8.6%)	9 (10.7%)	12 (24.5%)	.114
Cardiac	0	2 (2.4%)	4 (8.2%)	.680
Noncardiac	2 (5.7%)	6 (7.1%)	5 (10.2%)	.510
Unknown	1 (2.9%)	1 (1.2%)	3 (6.1%)	.491

Values are presented as mean ± SD or n (%). ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; MI, myocardial infarction; NYHA, New York Heart Association functional class; PCI, percutaneous coronary intervention; TIMI, Thrombolysis in Myocardial Infarction.

values of LVESV in the 1-year SPECT in all groups was remarkable. In addition, regional wall motion score and the site of most compromised segments were similar in the 3 groups despite the speculation that perhaps apical segments would exhibit greater impairment in PD than in RD patients. In contrast, the electrocardiographic extent of necrosis at 48 hours—which appears to be a marker of LV dilation in anterior STEMI at 3,[27] 6,[28] or 12 months[29]—was a predictor of PD at 3 years whereas it was negatively correlated with development of RD. The latter, in turn, was positively correlated with the history of arterial hypertension for which, in our view, there is no apparent explanation other than perhaps their possibly larger stunned myocardial mass linked to hypertension-related LV hypertrophy.

Although our study was not designed to assess survival, PD patients presented higher mortality than RD and SD

Table 3. Comparison of Baseline Clinical, Electrocardiographic, and Angiographic Data, as Well as Treatment During Index Hospitalization and 1-Year Gated-SPECT Features of Patients With First Anterior STEMI Included and Not Included in the Study (mean ± SD, or %)

Data	Included (n = 168)	Not included (n = 69)	*P* Value
Admission data			
Age, y	61.3 ± 12.3	58.3 ± 12.7	.092
Body surface area, m^3	1.90 ± 0.19	1.93 ± 0.18	.264
Female	27 (16%)	13 (17%)	.703
Hypertension	71 (42%)	33 (48%)	.473
Diabetes mellitus	36 (21%)	12 (17%)	.592
Smoking			.780
Active	91 (54%)	36 (52%)	
Past	32 (19%)	12 (18%)	
Peripheral vascular disease	25 (15%)	4 (6%)	.079
TnI, μg/L	128.4 ± 129.3	81.9 ± 101.2	.008
Heart rate, betas/min	83 ± 21	81 ± 18	.489
Blood pressure, mm Hg			
Systolic	132 ± 28	135 ± 33	.478
Diastolic	78 ± 17	79 ± 20	.697
48-h ECG			
Leads with Q waves	3.5 ± 2.2	3.3 ± 2.1	.520
Inferolateral leads with Q waves	0.9 ± 1.1	0.9 ± 1.1	1.0
∑STE, mm	4.2 ± 3.8	3.5 ± 4.0	.206
Leads with STE	2.5 ± 1.8	2.1 ± 1.9	.128
Max STE anterior leads, mm	1.7 ± 1.3	1.4 ± 1.3	.108
Max STE inferolateral leads, mm	0.2 ± 0.6	0.1 ± 0.5	.223
No. of vessels with ≥70% stenosis	(n = 143)	(n = 59)	.633
0	5 (3)	2 (3%)	
1	100 (70%)	39 (66%)	
2	25 (17%)	12 (21%)	
3	10 (7%)	4 (6%)	
Left main	3 (2%)	3 (5%)	
SPECT data at 1 year			
Resting perfusion score	11.1 ± 3.5	9.2 ± 3.5	<.001
Stress perfusion score	11.8 ± 3.5	10.1 ± 3.5	<.001
EF, %	42.7 ± 13.1	48.9 ± 14.0	.001
LVEDV, mL	142.6 ± 60.6	123.8 ± 67.1	.037
LVESV, mL	87.1 ± 52.4	71.4 ± 60.9	.047
In-hospital treatment			
Reperfusion therapy	144 (86%)	53 (77%)	.126
Thrombolysis	39 (23%)	14 (21%)	.671
Rescue PCI	21 (13%)	12 (17%)	.409
Primary PCI	105 (63%)	39 (56%)	.464
TIMI flow post 0-I	1 (1%)	1 (2)	.498
Pain onset to thrombolysis or primary PCI at ≤12 hours, min	278 ± 162	270 ± 158	.675
Late PCI at index hospitalization	21 (13%)	5 (7%)	.360
ACE inhibitors/ARBs	120 (71%)	52 (76%)	.631
Beta blockers	149 (88%)	59 (86%)	.516
Aldosterone receptor antagonists	13 (8%)	4 (6%)	.784
Aspirin	163 (97%)	67 (97%)	1.0
Clopidogrel	139 (83%)	59 (86%)	.702
Heparin	73 (44%)	33 (48%)	.567
IIb/IIIa glycoprotein inhibitors	102 (61%)	39 (57%)	.563
Nitrates	161 (96%)	62 (90%)	.124
Calcium antagonists	11 (7%)	2 (3%)	.356
Statins	124 (74%)	55 (80%)	.407
Follow-up, mo	(n = 168) 86.8 ± 22.8	(n = 69) 76.6 ± 22.7	.002
Death	24 (14.3%)	22 (17.5%)	.554
Cardiac	6 (3.6%)	2 (2.9%)	1.00
Noncardiac	13 (7.7%)	9 (10.0%)	.388
Unknown	5 (3.0%)	1 (1.4%)	.675

Values are presented as mean ± SD or n (%). Abbreviations as in Tables 1 and 2.

combined. The rate of readmission for heart failure or New York Heart Association functional class ≥2 also was higher, but the difference was not significant, probably owing to the reduced number of patients.

Study Limitations

The number of patients, especially the subset with RD, is too small to draw more solid conclusions on the course of LV volume changes beyond the first year in 3-year survivors of a first anterior STEMI, particularly regarding the subset treated with primary PCI. Furthermore, we provide no information as to the course of LV volumes in the subset of these patients who die or present a reinfarction during years 2 and 3. Another limitation is the lack of a second SPECT in an appreciable proportion of patients, owing in part to their decision to be followed by centers closer to their homes. Those patients, however, appeared to be at lower risk, presenting significantly smaller infarct size, higher EF, and lower LV volumes than those who were included. We also recognize that we failed to include exercise time in our data, which indeed could have been of interest. An additional drawback is the sole reliance on left atrial color flow area to categorize mitral regurgitation severity but it was the one that could be performed on admission 24 hours a day.

Conclusion

Our findings attest to the complexity of the remodeling process following a first anterior STEMI and suggest that at least beyond the first year LV volumes do not seem to evolve according to the 1-year measurements, regional wall motion, or site of segments involved. Therefore, their periodic assessment to evaluate the course of LV remodeling seems strongly warranted. Of particular interest is the notable reduction in LV volumes beyond the first year observed in 21% of patients with either normal or enlarged ventricles at 1 year, which could possibly be related to a late reduction in infarct size. These results need to be taken into account in the design and interpretation of investigations geared to improve our knowledge on the mechanisms of LV remodeling and of interventions aimed to reduce LV dilation after a STEMI.

Disclosures

None.

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