

Effect of Coronary Revascularization in Patients With Ischemic Cardiomyopathy Who Satisfy Viability Criteria on Gated-SPECT Assessment of Myocardial Perfusion

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Study on the effects of coronary revascularization and medical treatment on the prognosis of patients with ischemic cardiomyopathy who satisfy myocardial viability criteria on gated single-photon emission computed tomography (SPECT) assessment of myocardial perfusion. In total, 140 consecutive patients with ischemic cardiomyopathy were studied at rest using gated-SPECT and technetium-labeled contrast agents. During a mean follow-up period of 2.3 years after gated-SPECT, the rate of cardiac death in patients who underwent coronary revascularization (n=50) was 16% compared with 26.7% in those who received medical treatment (n=90). Thus, coronary revascularization had a protective effect (hazard ratio = 0.42; 95% confidence interval, 0.17–1.02) in patients with ischemic cardiomyopathy who satisfied myocardial viability criteria.

Key words: Ischemic cardiomyopathy. Myocardial viability. Scintigraphy. Revascularization. Prognosis.

Efecto de la revascularización coronaria en la miocardiopatía isquémica con criterios de viabilidad en la gated-spect de perfusión miocárdica

Estudio del efecto pronóstico de la revascularización coronaria (RC) y del tratamiento médico (TM) en los pacientes con miocardiopatía isquémica y criterios de viabilidad miocárdica en la *gated*-SPECT de perfusión miocárdica. Se estudió consecutivamente a 140 pacientes con miocardiopatía isquémica mediante *gated*-SPECT en reposo con compuestos de tecnecio. Durante un seguimiento medio tras la *gated*-SPECT de 2,3 años, la mortalidad cardiaca en los pacientes con RC (n = 50) fue del 16%, y en los que continuaron con TM (n = 90) fue del 26,7%. Así pues, la RC tuvo un efecto protector (*hazard ratio* = 0,42; intervalo de confianza del 95%, 0,17-1,02) en los pacientes con miocardiopatía isquémica y criterios de viabilidad.

Palabras clave: Miocardiopatía isquémica. Viabilidad miocárdica. Gammagrafía. Revascularización. Pronóstico.

INTRODUCTION

Given the elevated morbidity and mortality of patients with ischemic cardiomyopathy (IM), the diagnosis of myocardial viability (MV) in these patients is relevant

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as this can change the therapeutic strategy and improve prognosis.¹ Myocardial viability has been studied using different imaging techniques such as single-photon emission computed tomography (SPECT),² positron emission tomography (PET),³ ultrasonography,^{4,5} magnetic resonance imaging,⁶ and multidetector computed tomography.⁷ The prognosis of patients with a given level of MV according to gated-SPECT and technetium-labeled contrast agents varies depending on the treatment received. This work analyzes the effects of coronary revascularization (CR) and medical treatment (MT) on cardiac mortality (CM) in patients with AMI satisfying MV criteria according to gated-SPECT imaging performed at rest using technetium-labeled contrast agents.

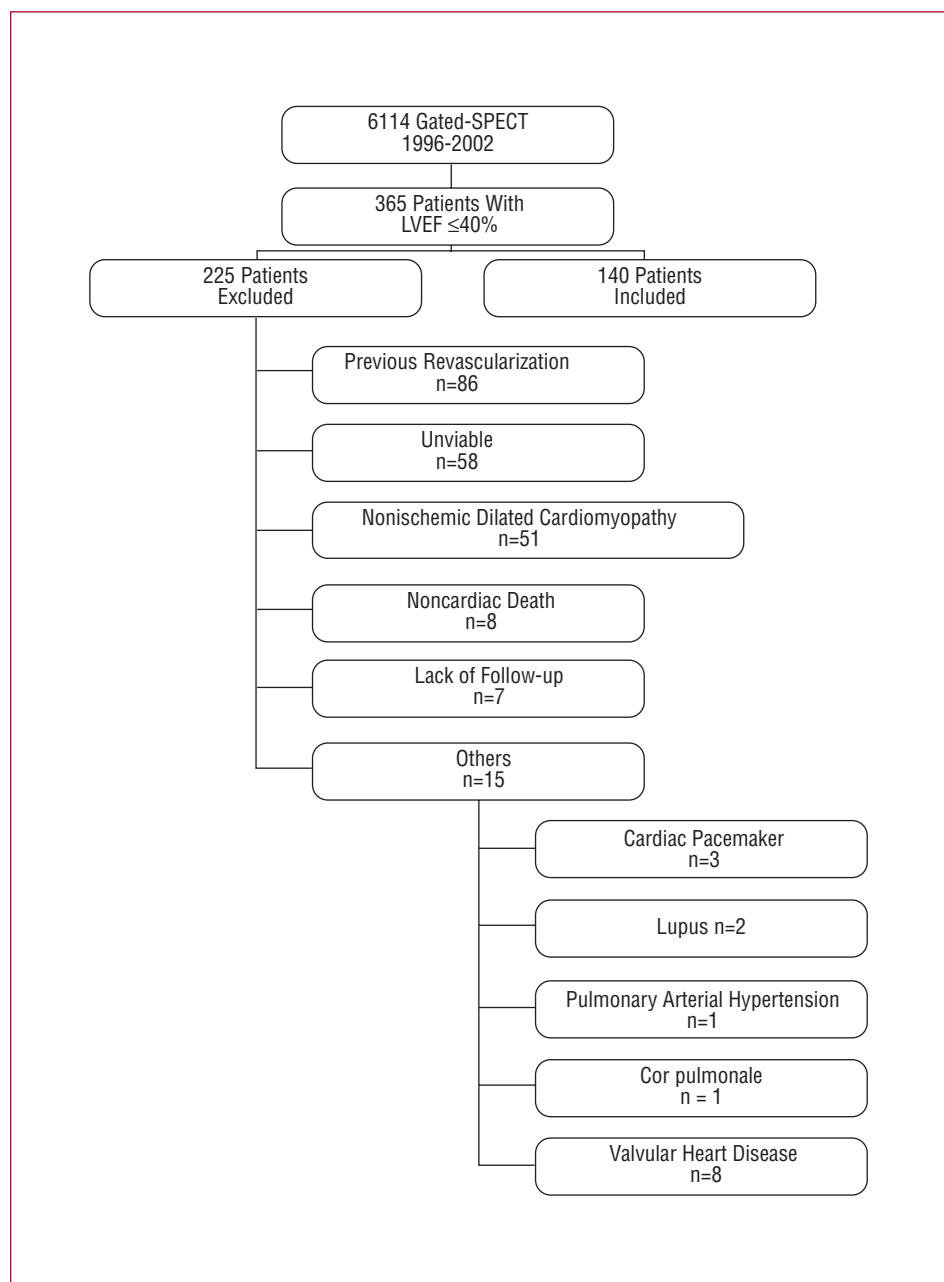


Figure 1. Flowchart of patients included in this study.

METHODS

Patients

Between July 1996 and July 2002, our nuclear cardiology unit assessed myocardial perfusion in 6114 consecutive patients using gated-SPECT with technetium-labeled contrast agents. The present study included 140 consecutive patients with AMI who fulfilled the selection criteria (patients with ischemic heart disease and an ejection fraction [EF] $\leq 40\%$ in the absence of any other associated heart disease who satisfied MV criteria and who had not undergone previous revascularization) (Figure 1).

Gated-SPECT Myocardial Perfusion at Rest

All patients were studied at rest using gated-SPECT. Each patient was administered a dose of 24 mCi of ^{99}Tc -tetrofosmin ($n=123$) or MIBI ($n=17$). The equipment used was a 90° dual-head gamma camera (E.cam, Siemens Medical Systems, Erlangen, Germany) provided with a high resolution collimator, 180° semicircular orbit, in step-and-shoot mode, starting at 45° right anterior oblique projection with image acquisition every 3° (25 s). Image acquisition was synchronized with the electrocardiogram R wave and the cardiac cycle was divided into 8 intervals. The reconstruction method was filtered back-projection (5th-order Butterworth filter; cutoff frequency, 0.4).

TABLE 1. Clinical and Gated-SPECT Characteristics^a

Clinical Characteristics	General Values (n=140)	MT (n=90)	CR (n=50)	P
Age, mean (SD), y	63.6 (11)	64.8 (12)	63.1 (11)	.362
Women, n (%)	26 (18.6)	23 (25.6)	3 (6)	.004
Previous AMI, n (%)	107 (76.4)	76 (84.4)	31 (62)	.003
Number of AMI	1.4 (0.7)	1.3 (0.8)	1.5 (0.7)	.178
Number of CRF	2.1 (0.8)	2.2 (0.9)	2.7 (0.9)	.458
Diabetes, n (%)	47 (33.6)	34 (37.8)	13 (26)	.157
Smoking, n (%)	87 (62.1)	52 (57.8)	35 (70)	.153
Dyslipidemia, n (%)	82 (58.6)	52 (57.8)	30 (60)	.798
AHT, n (%)	86 (61.4)	60 (66.7)	26 (52)	.088
Dyspnea (NYHA), n (%)				
I-II	19 (13.6)	11 (12.2)	8 (16)	.532
III-IV	33 (23.6)	20 (22.2)	13 (26)	.614
Angina (CCS), n (%)				
I-II	22 (15.7)	16 (17.8)	6 (12)	.368
III-IV	3 (2.1)	1 (1.1)	2 (4)	.258
Gated-SPECT				
LVEF, %	30 (7)	31.4 (7)	30.8 (6.7)	.679
ESV, mL	120.3 (60)	118.1 (58)	125 (52.9)	.492
EDV, mL	172.6 (71)	168.2 (70)	177.2 (61)	.447
RSCA/patient	1.3 (0.5)	1.2 (0.4)	1.4 (0.5)	.017
Anteroseptal SCD, n (%)	85 (60.7)	52 (57.8)	33 (66)	.340
Inferolateral SCD, n (%)	93 (66.4)	56 (62.2)	37 (74)	.157
SRS, wall thickening	17.8 (9.8)	17.6 (8.6)	17.9 (8.1)	.816
SRS, perfusion	19.6 (9.6)	19.5 (8.6)	19.8 (7.9)	.831

^aSCD indicates severe contractility dysfunction; CCS, Canadian Cardiovascular Society; MHR, maximum heart rate; LVEF, left ventricular ejection fraction; CRF, cardiovascular risk factors; AHT, arterial hypertension; AMI, acute myocardial infarction; NYHA, New York Heart Association functional classification; RSCD, regions with severe contractility dysfunction; CR, coronary revascularization; SPECT, single proton emission computed tomography; SRS, summed rest score; MT, medical treatment; EDV, end-diastolic volume; ESV, end-systolic volume.

Attenuation and scattering corrections were not performed. Myocardial viability was analyzed in akinetic and dyskinetic regions as well as in those with severe hypokinesia. All patients studied at rest using gated-SPECT satisfied the viability criteria accepted in our unit. That is, out of 17 myocardial segments, less than 3 had perfusion and wall thickening scores III-IV (severe dysfunction or absence of thickening) in the akinetic and dyskinetic regions.⁸

Follow-up

Mean clinical follow-up after gated-SPECT (2.4 [1.2] years; median, 2.3 [25th percentile = 1.4; 75th percentile = 3.2]) was conducted by the cardiologist in the hospital outpatient service (n=30) and by telephone (n=110). Cardiac mortality and the CR procedure (surgery or coronary angioplasty) were evaluated.

Study Design

This was a retrospective clinical study which analyzed the clinical characteristics of patients at rest using gated-SPECT and the effects of CR (surgery or coronary

angioplasty) at follow-up. The effect of treatment on CM was also studied.

Statistical Analysis

Continuous variables were compared using the Student *t* test for independent samples and expressed as mean (standard deviation). Differences between 2 proportions were compared with the χ^2 test or Fisher's exact test, and results given as percentages.

The effect of CR and MT were analyzed using Cox regression controlling for confounding and interaction. Interactions were assessed (CR and AMI [previous acute myocardial infarction], CR and RSCD [regions with severe contractility dysfunction] and CR and women) using an overall test of significance (chunk test) according to the likelihood ratio, without reaching statistical significance. The model included significant variables from the univariate analysis, plus the variables history of hypertension and diabetes. The relative risk of CR and of MT was expressed as hazard ratios (HR). The survival curves were compared using log-rank and Breslow tests (Kaplan-Meier method). A *P* value less than .05 was considered significant. The statistical analysis was

TABLE 2. Result of Cox Multivariate Regression Analysis With the Variables Introduced Into the Model^a

	χ^2	P	HR	95% CI
Coronary revascularization	3.778	.050	0.416	0.172-1.007
Men	0.566	.452	1.376	0.599-3.162
Previous AMI	0.205	.650	0.826	0.362-1.887
RSCD/patient	2.991	.084	1.955	0.914-4.180
Diabetes mellitus	0.289	.591	0.810	0.377-1.744
Arterial hypertension	0.029	.864	1.066	0.515-2.205

^aAMI indicates acute myocardial infarction; RSCD, regions with severe contractility dysfunction; HR, hazard ratio

performed using SPSS for Windows software, version 13.0. (SPSS, Chicago, Ill., USA)

RESULTS

Table 1 shows the clinical characteristics of the total population and those obtained with gated-SPECT at rest as well as these when grouped by CR and MT.

Following gated-SPECT, CM was 22.8% (n=32) during follow-up (2.3 [1.2] years). In revascularized patients (n=50), CM was 16.2% (n=8; 5.9/100 patients/y), and in MT patients (n=90) CM was 26.7% (n=24; 12.9/100 patients/y). The nonadjusted Kaplan-Meier analysis (Figure 2) showed that there were lower survival rates among MT patients, with the results almost reaching statistical significance. The adjusted treatment effect by Cox regression analysis (Table 2) showed a marginally significant protective effect against CM among the CR patients. Coronary revascularization multiplied the risk of CM by 0.42 compared to MT (95% confidence interval, 0.17-1.01; $P=.05$). No significant differences were found in CM in relation to the type of revascularization (surgical vs angioplasty, 17% vs 13.3%, respectively; $P=.73$).

DISCUSSION

A metaanalysis assessing different techniques showed that MV is a prognostic variable of CM and that mortality is lower among CR patients.⁹ However, to date, no studies have been conducted on the prognostic effect of CR in patients with AMI who satisfy MV criteria assessed by gated-SPECT at rest and technetium-labeled contrast agents. Positron emission tomography is the standard technique for studying MV, but it is expensive and rarely available in most hospitals. Thus, a good alternative is gated-SPECT with technetium-labeled contrast agents, which currently is the most widely used technique for assessing myocardial perfusion. Using this methodology, Levine et al¹⁰ observed that the sensitivity and diagnostic accuracy of myocardial viability improved when SPECT was synchronized with ECG.

In our series, the MT patients who satisfied MV criteria according to gated-SPECT imaging at rest had greater

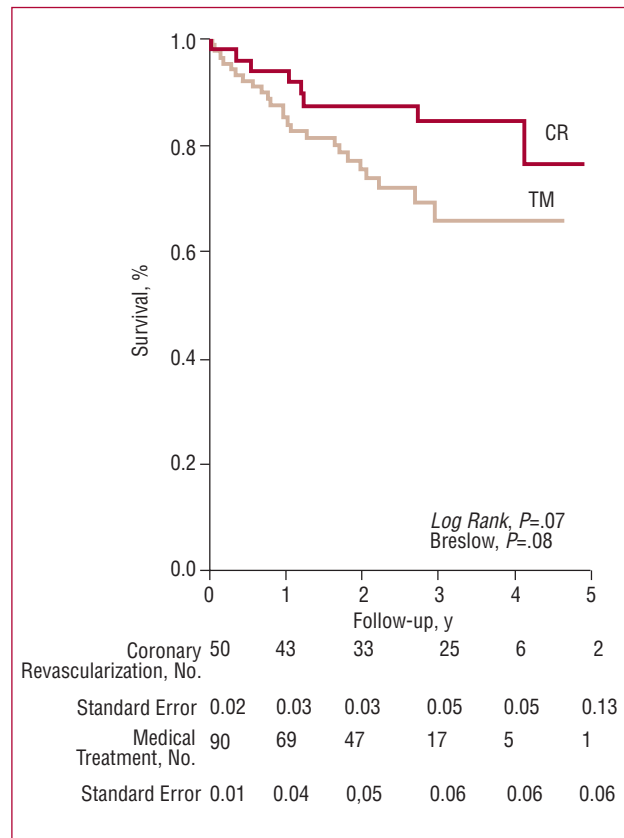


Figure 2. Kaplan-Meier survival analysis in patients with viable myocardium undergoing coronary revascularization (CR) and medical treatment (MT). "Standard error" refers to the cumulative survival rate.

CM than the CR patients, although the results were just below the limit of statistical significance. Annual mortality was double in MT patients with AMI and MV compared to that in CR patients. These results are compatible with those found in previous studies conducted with echocardiography,⁹ magnetic resonance imaging,¹¹ PET,^{3,12} and TI-201 myocardial perfusion scintigraphy.¹³ Studies that have used technetium together with PET to analyze myocardial metabolism have found a significant reduction in cardiac event rates (death, acute myocardial infarction, unstable angina, cardiac transplantation, and survived resuscitation) only in patients with viable

myocardium.¹⁴ A metaanalysis conducted by Allman et al,⁹ and a more recent one by Bourque et al,¹⁵ included studies with SPECT, PET and echocardiography with more than 1000 patients and found a close relationship between MV and significantly improved survival rates after a CR procedure.

Our study is based on a retrospective clinical analysis where the physician's decisions and some patient characteristics (age, comorbidity, unsuitable coronary anatomy) may have influenced therapeutic decisions regardless of the results obtained with gated-SPECT relating to MV. Although the hazard ratio is very high, the association of mortality with the type of treatment received is marginally significant, and so these results should be interpreted with caution. This is a limitation in our series and is also found in other published studies.

Based on our results, we conclude that coronary revascularization has a protective effect on patients with ischemic cardiomyopathy who satisfied myocardial viability criteria assessed by gated-SPECT myocardial perfusion imaging.

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