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Research Article

Clinical Management of Patients with Ischemic Cardiomyopathy with and without Scintigraphic Criteria of Viability and Ischemia in Gated SPECT

Guillermo Romero-Farina[1]*, Jaume Candell-Riera[1], Santiago Aguadé-Bruix[2], Albert Igual[3] and David García-Dorado[2]

[1]Cardiology Department, Hospital Universitari Vall d'Hebron, Institut de Recerca (VHIR), Universitat Autònoma de Barcelona, Spain
[2]Nuclear Medicine Department, Hospital Universitari Vall d'Hebron, Institut de Recerca (VHIR), Universitat Autònoma de Barcelona, Spain.
[3]Cardiac Surgery Department, Hospital Universitari Vall d'Hebron, Institut de Recerca (VHIR), Universitat Autònoma de Barcelona, Spain

***Corresponding Author**: Guillermo Romero-Farina, Nuclear Medicine Department and Cardiology Department, Hospital Universitari Vall d'Hebron, Universitat Autònoma de Barcelona, Paseo Vall d'Hebron, Barcelona, Spain.

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Abstract

Background: There are several reports on the evolution and prognosis of patients with ischemic cardiomyopathy. However, studies of their clinical profile and therapeutic management in clinical practice settings are really scarce. Aims: to analyze clinical decisions in patients with coronary artery disease and reduced left ventricular systolic function according to viability and ischemia criteria observed in myocardial perfusion gated SPECT.

Methods: During 6 years, 206 consecutive patients (mean age: 63 ± 11 years, 33 female) with coronary artery disease and left ventricular ejection fraction ≤40% were evaluated by means of gated SPECT with technetium labeled compounds. We evaluated the relationship between coronary angiography (CA), coronary revascularization (CR) and scintigraphic viability and ischemia criteria.

Results: A total of 72.8% (150/206) patients underwent CA. The mean age of the patients who underwent CA was lower (p = 0.027) and they had less often myocardial infarction (p = 0.001) and a higher ratio of angina (p = 0.003). A total of 28.6% patients with viable criteria were not studied by CA: in half of them because of poor clinical status and the rest did not have ischemia in the gated SPECT. Ischemic patients (HR:4.9; p < 0.001) and ejection fraction (HR:0.94; p = 0.015) were the independent predictors of CA. A total of 33.4% (69/206) patients were revascularized. Sixty-two per cent of the catheterized patients with viability criteria who were not revascularized did not have suitable coronaries. Surgical revascularization was significantly higher (p = 0.04) than PTCA in viable patients. Summed difference score (HR:1.1; p = 0.001) and triple-vessel disease (HR:1.9; p = 0.049) were independent predictors of CR. There were 71.4% with scintigraphic viability criteria in rest gated SPECT and 52.6% with ischemia in stress-rest gated SPECT. No significant differences in the indication of CA and CR in viable and non-viable patients were observed. However, the presence of global ischemia as well as ischemia at a distance from the necrotic region were significantly more common in revascularized patients.

Conclusion: In a clinical practice setting, the presence of ischemia is a more powerful factor than the presence of viability to indicate CA and CR in patients with ischemic cardiomyopathy.

Keywords: *Gated SPECT; Ischemia; Viability; Ischemic Cardiomyopathy, Coronary Angiography, Coronary Revascularization*

Abbreviations

CA: Coronary Angiography; CR: Coronary Revascularization; EF: Ejection Fraction; ESV: End Systolic Volume; Gated SPECT: Gated Single Photon Emission Computed Tomography; ICM: Ischemic Cardiomyopathy; MI: Myocardial Infarction; SDS: Summed Difference Score; SRS: Perfusion Summed Rest Score; SSS: Summed Stress Score

Introduction

Ischemic cardiomyopathy (ICM) is a disease with high morbidity and mortality [1,2]. There are several published studies on the evolution and prognosis of these patients [3-7]. However, reports on their clinical profile and therapeutic management in clinical practice settings are really scarce [8]. The main purpose of evaluating these patients by means of gated single photon emission computed tomography (gated SPECT) of myocardial perfusion is to assess myocardial viability, the presence of ischemia and left ventricular function. In practice, several features related to this type of cardiomyopathy are still unknown, as for example its prevalence among patients evaluated at Nuclear Cardiology Unit, the percentage of patients with viable and/or myocardial ischemia criteria in gated SPECT or how many of them are studied using coronary angiography (CA) and, finally, how many patients are or are not revascularized following angiographic or gated SPECT results. To get an answer to these questions we carried out a retrospective study of all the patients with ICM under myocardial perfusion gated SPECT seen in our Nuclear Cardiology Unit.

Methods

Patient selection

During 6 years, 6,114 patients were evaluated by means of myocardial perfusion gated SPECT with technetium labeled compounds. Three hundred and sixty-eight (6%) showed a left ventricular ejection fraction (EF) of ≤ 40%. From that group, 152 patients were excluded because of the presence of any other type of heart disease (n: 61), implanted pacemakers (n:10) or previous revascularization (n: 86); in 7 patients, clinical follow-up could not be completed. Therefore, 206 patients (mean age: 63 ± 11years, 33 female) with ICM were studied. One hundred and seventy-eight patients (84%) had had previous myocardial infarction (MI) (96 anterior, 56 inferolateral and 41 non-Q-wave). Following the judgement of the clinical cardiologist in our Nuclear Cardiology Unit, these 206 patients had undergone studies of viability or/and myocardial ischemia. With the aim of assessing the patients' clinical profile, the CA results, whenever this study was done, and the therapeutic decision taken thereafter, we analysed the results of the gated-SPECT and the clinical history of patients during a mean monitoring of 2.3 years after the scintigraphic study.

Myocardial perfusion gated-SPECT

As mentioned above, 156 patients underwent stress-rest gated SPECT and in 50 patients the study was done only at rest. As regards the stress-rest studies, a one-day protocol with technetium compounds (56% MIBI, 44% tetrofosmine) was followed. The stress test on an ergometric bicycle was done in 133 patients and dipyridamole was administered to 23 patients during the stress test as they did not reach 80% of predicted heart rate [9]. The first dose (30 - 60 seconds before ending the stress test) was of 8 mCi and the second (at rest) was of 24 mCi, with an interval longer than 45 minutes in between. The study was performed using a Siemens E.CAM gamma camera with a 90º double head with a low energy high resolution collimator and 180º semicircular orbit in "step-and-shoot" mode, starting with a right front oblique at 45º with twenty-five-second detections every 3 grades. Detection was synchronized with the R wave of the electrocardiogram and the cardiac cycle was segmented into 8 fractions. The reconstruction system used in this gamma camera was the filtered back projection (Butterwoth post-filter power 5 and 0.5 cut-off frequency). No corrections on attenuation or scatter were made. To measure perfusion and thickening, the left ventricle was divided into 17 segments [10] assigning a score from 0 to IV for perfusion (0= normal, I= low hypoperfusion, II= moderate hypoperfusion, III= severe hypoperfusion and IV= uptake absence) and for thickening (0= normal, I= low decrease, II= moderate decrease, III= severe decrease and IV= uptake absence). Perfusion summed rest score (SRS), summed stress score (SSS), summed difference score (SDS) and SRS thickening were evaluated [11,12]. We examined two myocardial regions: antero-apical (basal anterior, basal anteroseptal, basal inferoseptal, mid anterior, mid anteroseptal, mid inferoseptal, apical anterior, apical septal, and apical segments) and inferolateral (basal inferior, basal inferolateral, basal anterolateral, mid inferior, mid inferolateral, mid anterolateral, apical inferior and apical lateral segments). By means of gated SPECT at rest, we analyzed myocardial viability in regions with severe hypokinesia, akinesia and diskinesia and considered that the presence of ≥ 3 (> 17%) myocardial segments with perfusion score III-IV without systolic thickening was a valid criterion to identify a patient as having non-viable myocardium. We defined myocardial ischemia when there was SDS > 2 and ischemia at a distance (in a remote zone) when ischemia was present in a counter lateral region in the study of myocardial viability (regions with severe hypokinesia, akinesia and diskinesia).

EF and ventricular volume figures were calculated automatically in the gated SPECT at rest using the QGS® (Cedars-Sinai Medical Center, Los Angeles, CA) [13] programme.

Coronary angiography and coronary revascularization

The medical reports of all CA studies done in 150 patients were reviewed. We considered that coronary stenosis was significant when greater than 50% in any of the three main coronary arteries (left anterior descending, left circumflex and right coronary), or ≥ 50% in the left main coronary artery. Suitability for revascularization and the grade of coronary stenosis were also assessed.

All coronary revascularization (CR) procedures done after gated SPECT in 69 patients (54 CABG and 15 PTCA) were examined as well. All CABG procedures were performed by the same surgical team after a medical-surgical session where all the patients' medical histories, the gated SPECT and CA results were evaluated.

Statistical Analysis

All continuous data were expressed as mean (SD: standard deviation) and all non-continuous variables were expressed as percentages. Continuous variables were compared using the Student t test for unpaired samples. Differences between proportions were compared using the χ^2 test. Fisher´s exact test was used when < 5 patients were expected in any subgroup.

In the decision anlalysis regarding the practice of CA and CR, we evaluated myocardial viability in 206 patients by means of gated SPECT at rest and ischemia in 156 patients by means of gated SPECT at stress-rest. In the analysis of ischemia at a distance, we excluded patients who did not undergo a stress test (n = 50) and patients with severe abnormalities in myocardial contractility in both antero-apical and inferolateral regions (n = 39).

For the analysis of the variable from CA we excluded the patients in whom CA had been performed before gated SPECT. For the analysis of the ischemic predictors in CA and CR we excluded the patients that could not carry out a stress test. Multivariable models were constructed using Cox proportional hazards analysis. Forward stepwise selection techniques were used to identify variables independently associated with endpoints. For all multivariate modelling, the threshold for variable entry into models was $p < 0.05$; and for variable removal it was $p > 0.10$. The probability of event-free survival was calculated by use of the Kaplan-Meier's method, and survival curves were compared between different groups by use of the log-rank test. A value of $p < 0.05$ was considered as indicative of statistical significance. Data were analyzed by SPSS for Windows, version 13.0 (SPSS Inc, Chicago, ILL).

Results

A total of 71.4% (147/206) patients had viability criteria in the rest gated SPECT and 52.6% (82/156) had criteria for ischemia in the stress-rest gated SPECT (Figures 1 and 2).

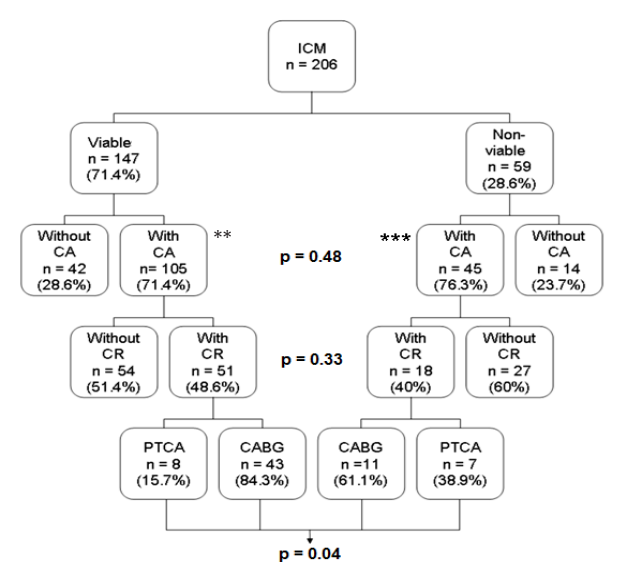

Figure 1: *Therapeutic management according to myocardial viability diagnosis in rest gated SPECT imaging. PTCA: Percutaneous Transluminal Coronary Angioplasty; CABG: Coronary Artery Bypass Grafting; CA: Coronary Angiography; CR: Coronary Revascularization; ICM: Ischemic Cardiomyopathy. ** CA before gated-SPECT: 52%, and CA after gated-SPECT: 47.6%. *** CA before gated-SPECT: 68.9%, and CA after gated-SPECT: 31.2%.*

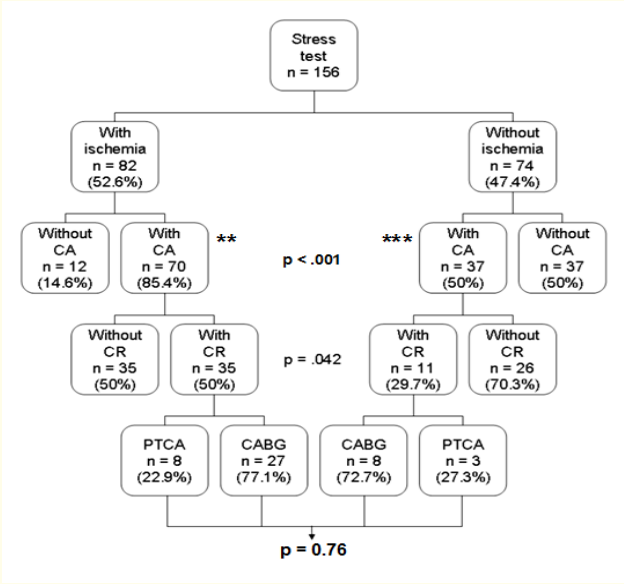

Figure 2: *Therapeutic management according to myocardial ischemia assessed in stress-rest gated SPECT imaging. PTCA: Percutaneous Transluminal Coronary Angioplasty; CABG: Coronary Artery Bypass Grafting; CA: Coronary Angiography; CR: Coronary Revascularization; ICM: Ischemic Cardiomyopathy. ** CA before gated-SPECT: 50%, and CA after gated-SPECT: 50%. *** CA before gated-SPECT: 67.6%, and CA after gated-SPECT: 32.4%.*

Coronary Angiography

A total of 72.8% (150/206) patients underwent CA (Figure 1) and 42.7% (64/150) of the CA studies were done after gated SPECT. The mean age of the patients who underwent CA was lower (p= 0.027) and they had less often myocardial infarction (p = 0.001) and a higher ratio of angina (p = 0.003) (Table 1). The gated SPECT showed that in the patients who had undergone CA fewer stress tests had been done (p = 0.016), while they had lower EF (p < 0.001), higher ESV (p = 0.013), higher SSS (p = 0.025), higher SDS (p < 0.001), and higher percentage of ischemia extension (p < 0.001) (Table 2). A total of 28.6% patients with viable criteria were not studied by CA: in half of them because of poor clinical status and the rest did not have ischemia in the gated SPECT.

Table 1. *Clinical characteristics of patients with and without coronary angiography.*

	No CA (n = 56)	**CA (n = 150)**	**p**
Age (years)	66.5 (SD = 12)	62.5 (SD = 11)	0.027
Female	10 (17.9%)	23 (15.3%)	0.660
Prior AMI	54 (96.4%)	116 (77.3%)	0.001
Nº of AMI / patient	1 (SD = 0.3)	1.5 (SD = 0.8)	< 0.001
Symptoms	46 (82%)	117 (78%)	0.515
Dyspnea (NYHA)	8 (14.3%)	41 (27.3%)	0.050
I	1(1.8%)	1 (0.7%)	0.471
II	4 (7.1%)	13 (8.7%)	1
III	2 (3.6%)	19 (12.7%)	0.069
IV	1 (1.8%)	8 (5.3%)	0.449
Angina (CCS)	6 (10.7%)	46 (30.7%)	0.003
I	1 (1.8%)	8 (5.3%)	0.449
II	1 (1.8%)	15 (10%)	0.075
III	0	3 (2%)	0.564
IV	4 (7.1%)	20 (13.3%)	0.328
Nº of risk factors/patient	2	2.2	0.253
Diabetes mellitus	19 (33.9%)	49 (32.7%)	0.864

CCS: Canadian Cardiovascular Society; CA: Coronary Angiography; MI: Myocardial Infarction; NYHA: New York Heart Association

Table 2: *Gated SPECT results of patients with and without coronary angiography.*

	No CA (n = 56)	**CA (n = 150)**	**p**
Rest gated-SPECT	7 (12.5%)	43 (28.7%)	0.016
LVEF (%)	32.9 (SD = 5.9)	29.2 (SD = 7.2)	< 0.001
ESV (ml)	113.3 (SD = 51)	136.7 (SD = 62.7)	0.013
EDV (ml)	167.3 (SD = 69.8)	188.5 (SD = 71.1)	0.057
SRS of thickening	19.7 (SD = 9.7)	21.9 (SD = 9.7)	0.153
SRS of perfusion	22 (SD = 9.9)	23.7 (SD = 9.4)	0.240

Viable patients	42 (75%)	105 (70%)	0.48
Stress test	**(n = 49)**	**(n = 107)**	
SSS of perfusion	24 (SD = 10)	27.5 (SD = 8.5)	0.025
SDS of perfusion	2 (SD = 1)	4.4 (SD = 4)	< 0.001
% myocardial ischemia	17.4% (SD = 13)	31.2% (SD = 17)	< 0.001
Ischemic patients	12/49 (24.5%)	70/107 (65.4%)	< 0.001
Ischemia at a distance	10 / 44 (22.7)	33 / 73 (45.2)	0.015

CA: Coronary Angiography; EDV: End-Diastolic Volume; ESV: End-Systolic Volume; LVEF: Left Ventricular Ejection Fraction; SDS: Summed Difference Score; SRS: Summed Rest Score; SSS: Summed Stress Score

Seventy-six percent of non-viable patients underwent CA (Figure 1). The majority of the coronary angiographies (86/150; 57.3%) were performed before the gated SPECT study, while the remaining non-viable patients went through coronary angiography due to the presence of myocardial ischemia detected by the gated-SPECT in territories with no previous infarction.

The patients with CA before gated SPECT (n: 86) were compared with the patients with CA after gated SPECT (n: 64). The patients with CA before gated-SPECT had a greater SRS (21 vs 25.8; p = 0.002), SSS (25.7 vs 29; p = 0.049), SRS of thickening (23.6 vs 19.7; p = 0.016), cardiac tissue necrosis (6.1% vs 10.7%; p = 0.041) and a smaller percentage of women (23.4% vs 9.3%; p = 0.017) than the patients with CA after gated SPECT.

For the multivariate analysis of the variable predictors of gated SPECT, we excluded the patients with CA before gated SPECT (n: 86). The mean interval between gated SPECT and CA was 129 (SD = 39) days. In the first multivariate model (previous AMI, angina and left ventricular ejection fraction, [n: 120]) the absence of previous AMI (HR: 2.3 [95% CI: 1.3-4.1]; p= 0.004) and the ejection fraction (HR: 0.96 [0.92-0.99]; p = 0.034) were independent predictors of CA.

In the second model (previous AMI, angina, left ventricular ejection fraction, SDS, % myocardial ischemia and ischemic patients; [n: 96]) myocardial ischemia was analyzed. The patients that could not carry out a stress test (n: 24) were excluded. Ischemic patients (HR: 4.9 [95% CI: 2.5-9.6]; p < 0.001) and ejection fraction (HR: 0.94 [0.9 - 0.99]; p= 0.015) were the independent predictors of CA.

Coronary Revascularization

A total of 33.4% (69/206) patients were revascularized. Surgical revascularization was significantly higher (p= 0.04) than PTCA in viable patients (Figure 1). The percentage of revascularized patients (56.3%) who underwent gated SPECT before CA was significantly higher (p= 0.04) when compared to those whose gated SPECT was done after CA (38.4%). Sixty-two per cent of the catheterized patients with viability criteria who were not revascularized did not have suitable coronaries, whereas the rest were not revascularized because of advanced stage of peripheral vascular disease (19%), previous severe stroke (10%) or renal failure (9%).

In the revascularized group (Table 3) the predominant patients were men (p = 0.004) with angina score IV (p = 0.006), higher frequency of previous infarction (p = 0.01) and three-vessel disease (p < 0.001) while in the group with medical treatment, one-vessel lesions were more common (p = 0.013). The percentage of patients who underwent only rest gated SPECT was higher in the revascularized group (p = 0.031); among these the number of patients with ischemia (p= 0.026) in the stress-rest gated SPECT, the SDS and the percentage of ischemia was higher (p < 0.001) (Table 4).

In the follow-up, there were no significant differences in the CR between viable and non-viable patients (Figure 1 and 3A) except for the patients with and without ischemia (Figure 2 and 3B). Thirty-four non-viable patients had ischemia at a distance and 57% of them were revascularized. This rate was significantly higher (p = 0.03) than in non-revascularized patients (14%). With respect to the patients

with stress test (n: 156), CR was significantly higher in patients with myocardial ischemia both in non-viable (n: 46) and viable patients (n: 110) (Figure 4A and 4B). The univariate analysis highlighted the greater importance of global myocardial ischemia and ischemia at a distance compared to the presence of viability for indicating CR procedure.

Table 3: *Clinical and angiographic characteristics of patients with coronary revascularization and medical treatment.*

	MT (n = 137)	**CR (n = 69)**	**p**
Age (Years)	63.9 (SD = 12)	62.9 (SD = 9.7)	0.533
Female	29 (21.2%)	4 (5.8%)	0.004
Previous AMI	121 (88.3%)	49 (71%)	0.002
Nr. of AMI / patient	1.3 (SD = 0.7)	1.6 (SD = 0.7)	0.01
Symptoms	105 (76.6%)	58 (84.1%)	0.216
Dyspnea (NYHA)	27 (19.7%)	22 (31.9%)	0.053
I	2 (1.5%)	0	0.552
II	8 (5.8%)	9 (13%)	0.076
III	13 (9.6%)	8 (11.6%)	0.637
IV	4 (2.9%)	5 (7.2%)	0.152
Angina (CCS)	29 (21.2)	23 (33.3%)	0.058
I	8 (5.8%)	1 (1.4%)	0.277
II	10 (7.3%)	6 (8.7%)	0.724
III	1 (0.7%)	2 (2.9%)	0.260
IV	10 (7.3%)	14 (20.3%)	0.006
Coronary angiography	81 (59.1%)	69 (100%)	0.000
1 vessel disease	21 / 81 (25.9%)	7 / 69 (10.1%)	0.013
2 vessel disease	25 / 81 (39.9%)	13 / 69 (18.8%)	0.092
3 vessel disease	34 / 81 (42%)	49 / 69 (71%)	< 0.001
LAD stenosis 100%	28 / 81 (34.6%)	21 / 69 (30.4%)	0.591
LCX stenosis 100%	11/ 81 (13.6%)	11 / 69 (15.9%)	0.684
RCA stenosis 100%	24 / 81 (29.6%)	29 / 69 (42%)	0.113
Total occlusions/patient	0.7 (SD = 0.7)	0.8 (SD = 0.7)	0.410
Main left disease	20 / 81 (24.7%)	25 / 69 (36.2%)	0.124

CR: Coronary Revascularization; LAD: Left Anterior Descending; LCX: Left Circumflex Artery; MT: Medical Treatment; RCA: Right Coronary Artery; CCS: Canadian Cardiovascular Society, CA: Coronary angiography, MI: Myocardial infarction, NYHA: New York Heart Association

Table 4: *Gated SPECT results of patients with coronary revascularization and medical treatment.*

	MT (n = 137)	**C R (n = 69)**	**P**
Rest gated-SPECT	27 (19.7%)	23 (33.3%)	0.031
LVEF (%)	30.5 (SD = 7.2)	29.4 (SD = 6.7)	0.291
ESV (ml)	131 (SD = 65)	129 (SD = 49)	0.831

EDV (ml)	184 (SD = 72)	180 (SD = 57)	0.673
SRS of thickening	21.4 (SD = 10)	21 (SD = 9)	0.782
SRS of perfusion	23.2 (SD = 9)	23.4 (SD = 9)	0.867
Viable patients	96 (70.1%)	51 (73.9%)	0.565
Stress test	**(n = 110)**	**(n = 46)**	
SSS of perfusion	25.9 (SD = 4)	27.7 (SD = 8)	0.264
SDS of perfusion	3 (SD = 3)	6.2 (SD = 4)	< 0.001
% myocardial ischemia	16 (SD = 10)	31 (SD = 20)	< 0.001
Ischemic patients	47 / 110 (42.7%)	35 / 46 (76.1%)	< 0.001
% non-viable myocardial	9 (SD = 11)	7.6 (SD = 10)	0.396
Ischemia at a distance	22 / 88 (30.7%)	16 / 29 (55.2%)	0.018

CA: Coronary Angiography; EDV: End-Diastolic Volume; ESV: End-Systolic Volume; LVEF: Left Ventricular Ejection Fraction; SDS: Summed Difference Score; SRS: Summed Rest Score; SSS: Summed Stress Score

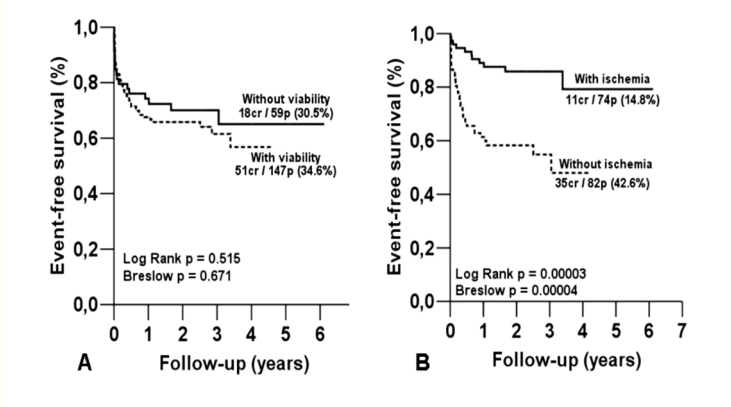

Figure 3: *Kaplan Meier's curves for the practice of coronary revascularization. During the follow-up, no significant differences were observed between viable and non-viable patients (A) except when ischemia was considered (B).*

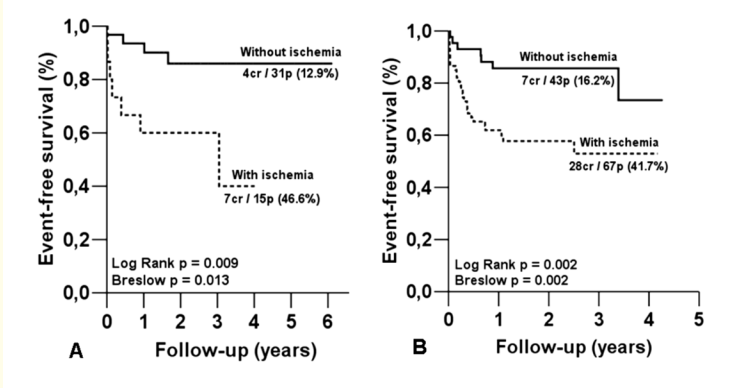

Figure 4: *Kaplan-Meier's analysis for the practice of coronary revascularization. The presence of ischemia was decisive in non-viable patients (A) as well as in viable patients (B).*

In the first multivariate model (not to be able to carry out a stress test, gender, previous AMI and angina IV, [n = 206]) the absence of prior AMI (HR: 2.01 [95% CI: 1.2 - 3.4]; p = 0.01) was the only independent predictor of CR. In the second model we included the patients with CA (stress test, gender, previous AMI, angina IV and triple-vessel disease, [n = 150]), and triple-vessel disease (HR: 1.93 [95% CI: 1.1 - 3.3]; p = 0.014) was the only independent predictor of CR. In the third model, we included the patients studied by means of stress test and CA (gender, previous AMI, angina IV, triple-vessel disease, SDS, % myocardial ischemia and ischemic patients; [n = 107]), and SDS (HR: 1.1 [95% CI: 1.04 - 1.2]; p = 0.001) and triple-vessel disease (HR: 1.9 [95% CI: 1 - 3.5]; p = 0.049) were independent predictors of CR.

Discussion

Although guidelines recommend that all patients with stable ischemic cardiomyopathy should be studied from the anatomical and functional points of view, little is known about the clinical profile and therapeutic management of these patients in hospital practice. In this retrospective study, we have attempted to assess the clinical approach and practice at a third-level hospital which has a Nuclear Cardiology Unit and a catheterization laboratory. These two units have the capacity for undertaking all procedures requested by the attending cardiologist as well as studies for the evaluation of viability and/or ischemia.

When we evaluated all the patients with ICM studied by means of myocardial perfusion gated SPECT during 6 years a remarkable finding was that 27% of the patients had not undergone catheterization. The ratio of patients with and without scintigraphic criteria of viability who underwent CA was not significantly different to that of patients who were not catheterized. However, patients who underwent CA presented more symptoms due to angina, lower left ventricular systolic function and more severe ischemia in the stress g-SPET. Multivariate regression analysis demonstrated that absence of previous AMI, myocardial ischemia and left ventricular ejection fraction were independent predictors of CA.

Another striking finding is that almost the same rates of viable and non-viable patients (34.7% and 30.5% respectively) underwent revascularization. Both percentages are comparable to those in previous reports which stated that the myocardial viability study had been done by ^{201}Tl [14,15], ^{18}FDG [16,17] and echocardiogram [18-20]. Thus, in the Gioia., *et al*. [14] series, 45% out of 85 patients with EF < 40% studied by SPECT with rest-distribution ^{201}Tl were revascularized; in the Pagley., *et al.* [15] series, also done with rest-distribution ^{201}Tl, 47% of the viable patients and 53% of the non-viable patients were revascularized. In the Beanlands., *et al.* [17] series 69% of the viable patients in the images of ^{18}FDG were revascularized and the same happened with 46% of the viable patients in the Smart., *et al.* [20] series. In our series, surgical revascularization was more frequent than PTCA in viable patients as compared with non-viable ones.

In our evaluation, the most striking finding, not clearly defined in previous reports was the fact that, the presence of ischemia in the gated SPECT was significantly more important than myocardial viability either for the indication of CA or CR. Thus, when reversible stress-rest was detected in the gated SPECT, the indication of CA as well as CR was more frequent. Multivariate regression analysis demonstrated that absence of previous AMI, extent of ischemia and triple-vessel disease were independent predictors of CR.

Bourque., *et al*. [21] published a meta-analysis of myocardial viability and CR that included a total of 1,244 patients from nine published studies [22-29]. Although not all the patients in that meta-analysis had an EF lower than 40%, there was a statistically significant association between the myocardial viability criteria and the RC. In our series 51.4% of the viable patients who underwent coronary angiography were not revascularized due to three factors: their coronary arteries were not suitable, they rejected it and there was high surgical risk (9.4%).

Bourque., *et al*. [8] analysed retrospectively 2,951 patients with ICM (left ventricular ejection fraction lower than 40% and a minimum of one coronary stenosis ≥ 75%) assessed in the catheterization laboratory. A total of 616 (20.9%) out of the 2,951 patients had been studied by myocardial perfusion SPECT (done after the CA in the 39% of the cases). This ratio is comparable to ours in the series where the evaluated patients came from the Nuclear Cardiology Unit. In the Bourque., *et al.* [8] group of patients evaluated by SPECT, 40% were revascularized during the follow-up; this result was also comparable to our group where 46% of the patients studied in Nuclear

Cardiology Unit and evaluated by coronary angiography were revascularized. Another interesting fact is that CR procedures were more frequent in those patients who underwent SPECT before cardiac catheterization in our series (56.3% vs 43.7%, p = 0.04) as well as in Bourque., *et al.* [8] series (61.6% vs 38.4%, p = 0.019). Probably, many coronary angiographies are not recommended when there are no viability criteria or ischemia in the myocardial perfusion gated SPECT and, on the other hand, in the presence of scintigraphic ischemia, patients undergo percutaneous revascularization.

Limitations

This is a retrospective, observational study from a Nuclear Cardiology Unit of a single center. The decision to revascularize patients does not only depend on ischemia/viability criteria. Referral bias could therefore be a problem. It cannot be excluded that only patients with doubtful symptoms were referred for ischemia assessment. For viability assessment, it is possible that the sickest patients were not referred since their operative risk was estimated as too high. A second objection might be that the gated SPECT using technetium compounds was not the ideal technique to detect myocardial viability in this type of patients. Nevertheless, the correlation of this technique with others such as PET, echocardiography with low doses of dobutamine and MR is good and it is, as well, the technique usually implemented is our centre with this aim.

Conclusions

In our series of patients with ICM evaluated at the Nuclear Cardiology Unit, significant differences in the rate of indication of CA and CR for viable or non-viable patients were not observed. However, both global ischemia and ischemia at a distance from the necrotic region were significantly higher in revascularized patients. This is why diagnosis of myocardial ischemia seems to be more compelling than diagnosis of viability to take therapeutic decisions in those patients.

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Conflict of Interest

All authors have read and approved the manuscript and there is no potential conflict of interest in connection with the submitted article.

Bibliography

1. Bourque JM., *et al*. "Radionuclide viability testing: should it affect treatment strategy in patients with cardiomyopathy and significant coronary artery disease?" *American Heart Journal* 145.5 (2003): 758-767.

2. Curtis JP., *et al*. "The association of left ventricular ejection fraction, mortality, and cause of death in stable outpatients with heart failure". *Journal of the American College of Cardiology* 42.4 (2003): 736-742.

3. Bax JJ., *et al*. "Prognostic value of perfusion-FDG mismatch in ischemic cardiomyopathy". *Journal of Nuclear Cardiology* 9.6 (2002): 675-677.

4. Meluzin J., *et al*. "Prognosis of patients with chronic coronary artery disease and severe left ventricular dysfunction. The importance of myocardial viability". *European Journal of Heart Failure* 5.1 (2003): 85-93.

5. Santana CA., *et al*. "Incremental prognostic value of left ventricular function by myocardial ECG-gated FDG PET imaging in patients with ischemic cardiomyopathy". *Journal of Nuclear Cardiology* 11.5 (2004): 542-550.

6. Rizzello V., *et al*. "Long-term prognostic value of myocardial viability and ischemia during dobutamine stress echocardiography in patients with ischemic cardiomyopathy undergoing coronary revascularization". *Heart* 92.2 (2005): 239-244.

7. Chirinos JA., *et al*. "Usefulness of C-reactive protein as an independent predictor of death in patients with ischemic cardiomyopathy". *American Journal of Cardiology* 95.1 (2005): 88-90.

8. Bourque JM., *et al*. "Clinical characteristics and referral pattern of patients with left ventricular dysfunction and significant coronary artery disease undergoing radionuclide imaging". *Journal of Nuclear Cardiology* 11.2 (2004): 118-125.

9. Candell-Riera J., *et al*. "Simultaneous dipyridamole/maximal subjective exercise with ^{99m}Tc-MIBI SPECT: Improved diagnostic yield in coronary artery disease". *Journal of the American College of Cardiology* 29.3 (1997): 531-536.

10. Cerqueira MD., *et al*. "Standardized myocardial segmentation and nomenclature for tomographic imaging of the heart: a statement for healthcare professionals from the Cardiac Imaging Committee of the Council on Clinical Cardiology of the American Heart Association". *Circulation* 105.4 (2002): 539-542.

11. Kubo S., *et al*. "Assessment of the effect of revascularization early after CABG using ECG-gated perfusion single-photon emission tomography". *European Journal of Nuclear Medicine and Molecular Imaging* 28.2 (2001): 230-239.

12. Emmett L., *et al*. "Reversible regional wall motion abnormalities on exercise technetium-99m-gated cardiac single photon emission computed tomography predict high-grade angiographic stenosis". *Journal of the American College of Cardiology* 39.6 (2002): 991-998.

13. Germano G., *et al*. "Automatic quantification of ejection fraction from gated myocardial perfusion SPECT". *Journal of Nuclear Medicine* 36.11 (1995): 2138-2147.

14. Gioia G., *et al*. "Prognostic value of rest-redistribution tomographic thallium-201 imaging in ischemic cardiomyopathy". *American Journal of Cardiology* 75.12 (1995): 759-762.

15. Pagley PR., *et al*. "Improved outcome after coronary bypass surgery in patients with ischemic cardiomyopathy and residual myocardial viability". *Circulation* 96.3 (1997): 793-800.

16. Haas F., *et al*. "Preoperative positron mission tomographic viability assessment and perioperative and post-operative risk in patients with advanced ischemic heart disease". *Journal of the American College of Cardiology* 30.7 (1997): 1693-1700.

17. Beanlands RS., *et al*. "Delay in revascularization is associated with increased mortality rate in patients with severe left ventricular dysfunction and viable myocardium on fluorine 18-fluorodeoxyglucose positron emission tomography imaging". *Circulation* 98.19 (1998): II51- II56.

18. Meluzin J., *et al*. "Prognosis value of the amount of dysfunctional but viable myocardium in revascularized patients with coronary artery disease and left ventricular dysfunction". *Journal of the American College of Cardiology* 32.4 (1998): 912-920.

19. Bax JJ., *et al*. "Improvement of left ventricular ejection fraction, heart failure symptoms and prognosis after revascularization in patients with chronic coronary artery disease and viable myocardium detected by dobutamine stress echocardiography". *Journal of the American College of Cardiology* 34.1 (1999): 163-169.

20. Smart SC., *et al*. "Dobutamine-atropine stress echocardiography for risk stratification in patients with chronic left ventricular dysfunction". *Journal of the American College of Cardiology* 33.2 (1999): 512-521.

21. Bourque J., *et al*. "Revascularization in patients with coronary artery disease, left ventricular dysfunction, and viability: a meta-analysis". *American Heart Journal* 146.4 (2003): 621-627.

22. Anselmi M., *et al*. "Prognostic value of detection of myocardial viability using low-dose dobutamine echocardiography in infarcted patients". *American Journal of Cardiology* 81.12A (1998): 21G-28G.

23. Afridi I., *et al*. "Myocardial viability during dobutamine echocardiography predictors survival in patients with coronary artery disease and severe left ventricular systolic dysfunction". *Journal of the American College of Cardiology* 32.4 (1998): 921-926.

24. vom Dahl J., *et al*. "Effect of myocardial viability assessed by technetium-99m-sestamibi SPECT and fluorine-18-FDG PET on clinical outcome in coronary artery disease". *Journal of Nuclear Medicine* 38.5 (1997): 742-748.

25. Eitzman D., *et al*. "Clinical outcome of patients with advanced coronary artery disease after viability studies with positron emission tomography". *Journal of the American College of Cardiology* 20.3 (1992): 559-565.

26. Yoshida K., *et al*. "Quantitative relation of myocardial infarction size and myocardial viability by positron tomography to left ventricular ejection and 3-year mortality with and without revascularization". *Journal of the American College of Cardiology* 22.4 (1993): 984-997.

27. Di Carli MF., *et al*. "Value of metabolic imaging with positron emission tomography for evaluating prognosis in patients with coronary artery disease and left ventricular dysfunction". *American Journal of Cardiology* 73.8 (1994): 527-533.

28. Lee KS., *et al*. "Prognosis of patients with left ventricular dysfunction, with and without viable myocardium after myocardial infarction: relative efficacy of medical therapy and revascularization". *Circulation* 90.6 (1994): 2687-2694.

29. Senior R., *et al*. "Myocardial viability on echocardiography predicts long-term survival after revascularization in patients with ischemic congestive heart failure". *Journal of the American College of Cardiology* 33.7 (1999): 1848-1854.

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