ORIGINAL ARTICLE

General Characteristics and Outcome of Patients with Acute Myocardial Infarction in Argentina According to Body Mass Index. (ARGEN-IAM-ST Registry)

Características generales y evolución según el índice de masa corporal en pacientes con Infarto Agudo de Miocardio en Argentina. (Registro ARGEN-IAM-ST)

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ABSTRACT

Background: Body mass index (BMI) in overweight and obesity ranges is an increasingly frequent cardiovascular risk factor. Its prognostic value is debatable in the setting of acute myocardial infarction (AMI).
Objectives: The aim of this study is to acknowledge the clinical characteristics, reperfusion strategies outcome of the cases included in the ARGEN-IAM ST according to BMI.
Methods: We conducted a prospective study of the cases included in the registry. Patients with incomplete anthropometric data were excluded. Three groups were defined: healthy BMI: < 25 kg/m² (G1), overweight: BMI between 25 and 29.9 kg/m² (G2) and obesity: BMI ≥ 30 kg/m² (G3).
Results: 2925 cases were included. Patients in G3 were younger (G1: 63 ± 12, G2: 61 ± 11, G3: 60 ± 11 years, p = 0.0001), and had higher incidence of diabetes (G1: 11%, G2: 22%, G3: 28%; p = 0.0001) and dyslipidemia (G1: 35%, G2: 40%, G3: 43%; p = 0.01). There were no differences in door-to-balloon time (median 104 minutes in G1, 110 in G2 and 110 in G3, p = 0.27), two-vessel disease or greater (G1 38%, G2 34.5% and G3 37%; p = 0.26) and in-hospital mortality (G1 9.7%, G2 7.5% and G3 8.4%; p = 0.22). In multivariate analysis Killip class other than A (OR: 20.1; 95% CI 13.1-30.8; p < 0.0001), age (OR: 1.7; 95% CI 1.2-2.5; p < 0.0001) and two-vessel disease or greater (OR: 1.5; 95% CI 1.03-2.1; p < 0.0001) were independent predictors of in-hospital mortality.
Conclusions: Overweight and obese patients were younger, with higher incidence of diabetes and dyslipidemia. There were no significant differences in the type of presentation, treatment and complications. In multivariate analysis, overweight and obesity were not predictors of mortality.

Key Words: Myocardial Infarction - Body Mass Index - Registries - Argentina

RESUMEN

Introducción: El índice de masa corporal (IMC) en rangos de sobrepeso y obesidad es un factor de riesgo cardiovascular cada vez más frecuente. Su valor pronóstico es discutido en el contexto del infarto agudo de miocardio (IAM).
Objetivos: Conocer características basales, estrategias de reperfusión y evolución de los casos incluidos del registro ARGENIAM ST según el IMC.
Material y Métodos: Estudio prospectivo de los casos incluidos en el registro. Se excluyeron los que no presentaban datos antropométricos completos. Se definieron 3 grupos; IMC saludable: <25 kg/m² (G1), sobrepeso: IMC entre 25 y 29,9 kg/m² (G2) y obesidad: IMC mayor o igual a 30 kg/m² (G3).
Resultados: Se incluyeron 2925 casos. Los pacientes del G3 tenían menor edad (G1: 63 ± 12, G2: 61 ± 11, G3: 60 ± 11 años, p = 0,0001), más frecuentemente diabetes (G1: 11%, G2: 22%, G3: 28%; p = 0,0001) y dislipidemia (G1: 35%, G2: 40%, G3: 43%; p = 0,01). No encontramos diferencias en el tiempo puerta balón, (medianas de 104 minutos en G1, 110 en G2 y 110 en G3, p = 0,27), la enfermedad de dos o más vasos (G1 38%, G2 34,5% y G3 37%; p = 0,26) y la mortalidad intrahospitalaria (G1 9,7%, G2 7,5% y G3 8,4%; p = 0,22). En el análisis multivariado el Killip y Kimball no A (OR: 20,1; IC95% 13,1-30,8; p <0,0001), la edad (OR: 1,7; IC95 1,2-2,5; p <0,0001) y la enfermedad de dos o más vasos (OR: 1,5; IC95% 1,03-2,1; p <0,0001) fueron predictores independientes de mortalidad en la internación.
Conclusiones: Los pacientes con sobrepeso y obesidad eran más jóvenes, con más antecedentes de diabetes y dislipidemia. No hubo diferencias significativas en la forma de presentación, tratamiento y complicaciones. En el análisis multivariado el sobrepeso y la obesidad no fueron predictores de mortalidad.

Palabras clave: Infarto del Miocardio - Índice de Masa Corporal - Sistemas de Registros - Argentina

Abbreviations

BMI	Body mass index	**ARGEN-IAM-ST**	National Registry of ST-segment Elevation Myocardial Infarction
AMI	Acute myocardial infarction		

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INTRODUCTION

Nowadays, obesity represents and epidemic that has increased its prevalence on almost every continent. Overweight and obesity are risk factors for heart failure, atrial fibrillation and ventricular arrhythmias. (1) Several studies in primary prevention showed a direct association between body mass index (BMI) in overweight and obesity ranges with increased mortality. (2,3) However, studies on acute coronary syndromes have reported controversial results, and many authors have described the "obesity paradox". (4,5) The association between increased BMI and cardiovascular disease is complex as different pathophysiological mechanisms are involved, such as subclinical inflammation, neurohumoral activation, abnormal insulin concentrations, and increased free fatty acid exchange, among others. (6)

The aim of this study is to acknowledge the clinical characteristics, reperfusion strategies and outcome of the patients included in the ARGEN-IAM ST according to BMI.

METHODS

We conducted a prospective observational cohort study of cases included in the ARGEN-IAM-ST Registry in its initial and continuing phase between 2015 and 2019, which included 247 centers nationwide. On admission, BMI was estimated according to the formula: weight (kg)/height $(m)^2$. Three groups were defined; G1: BMI ≤ 25 kg/m^2 (healthy weight), G2: BMI between 25-29.9 kg/m^2 (overweight) and G3: BMI >30 kg/m^2 (obesity). All ST-elevation MI patients with available anthropometric data in the registry were included in the study. The baseline characteristics, clinical presentation, type of reperfusion strategy and in-hospital complications according to the definitions previously established in the registry were analyzed by group. (7)

Statistical analysis

Quantitative variables are expressed as mean and standard deviation, or median and interquartile range 25%-75%, according to their distribution. Qualitative variables are presented as frequencies and percentages. Continuous variables with normal and non-gaussian distribution were compared using the Student's t test or the Wilcoxon rank sum test, respectively. Discrete variables were compared using the chi-square test or Fisher's exact test. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of in-hospital mortality. All the variables with a p value < 0.05 that predicted in-hospital mortality in univariate analysis were included in multiple logistic regression analysis, in addition to overweight and obesity. The results are expressed as odds ratio (OR) and its corresponding 95% confidence interval (CI). All the calculations were performed using Epi-Info 7.2.2.6 software package for Windows.

Ethical considerations

The protocol design of the ARGEN-IAM-ST registry was evaluated and approved by the Committee on Bioethics of the Argentine Society of Cardiology, and was subjected to evaluations of the local committees, depending on the local regulations and institutional policies.

RESULTS

Of the total registry population (n = 3331), 406 patients were excluded due to lack of adequate anthropometric data to calculate the BMI; thus, 2925 cases were analyzed. According to BMI, 605 patients (20.7%) were allocated to G1, 1466 (50.1%) to G2 and 854 (29.2%) to G3. Mean BMI for all the groups was 28.4 ± 5 kg/m^2; 23.2 ± 1.5 kg/m^2 in G1, 27.3 ±1.4 kg/m^2 in G2 and 34 ± 4 kg/m^2 in G3. Mean age was 63 ± 12 in G1, 61 ± 12 in G2 and 60 ± 11 years in G3 (p < 0.0001). Male sex predominated in G2 (G1 72.2%, G2 83% and G3 78.2%; p < 0.001). Patients in G3 had higher prevalence of hypertension (50.8% in G1, 58.1% in G2 and 65.4% in G3; p < 0.0001) diabetes, (G1 11.4%, G2 22.4%, G3 27.9%; p < 0.0001) and dyslipidemia, (G1 35.4%, G2 40.3% and G3 43.3%; p = 0.01) (Table 1). BMI was significantly higher in patients with dyslipidemia (28.8 ± 5 vs. 28 ± 4 kg/m^2, p < 0.001), hypertension (28.9 ± 5 vs. 27.6 ± 4 kg/m^2, p < 0.001) and diabetes (30 ± 5 vs. 28 ± 4 kg/m^2, p < 0.001). There were no differences in the outcome and incidence of complications.

On admission, anterior infarction according to the electrocardiogram occurred in 47% in G1, 46.1% in G2 and 47.2% in G3 (p = 0.48) and Killip class A was observed in 76.9% of patients in G1, 78.5% in G2 and 75.7% in G3 (p = 0.27). Echocardiographic examination reported severe reduction of left ventricular ejection fraction in 13.1%, 9.7% and 9.7 %, in G1, G2 and G3, respectively (p = 0.05). There were no differences in time to reperfusion and reperfusion strategies (Table 2). There were no differences in mortality among the groups: G1 9.7%, G2 7.5% and G3 8.4% (p = 0.89). There were significantly fewer bleeding events (G1 5.6%, G2 2.8% and G3 3.4%; p < 0.001), without differences in the rest of the complications (Table 3). Multivariate analysis included age, female sex, diabetes, hypertension, Killip class other than A, two-vessel disease or greater, previous AMI, severe left ventricular dysfunction, reperfusion on admission, and excess weight (G2 and G3). Killip class other than A, (OR: 20.1; 95% CI 13.1-30.8; p < 0.0001), age (OR: 1.7; 95% CI 1.2-2.5; p < 0.0001) and two-vessel disease or greater (OR:1.5; 95% CI 1.03-2.1; p < 0.0001) were independent predictors of in-hospital mortality.

DISCUSSION

Excess weight is an increasingly frequent cardiovascular risk factor in our society. In Argentina its prevalence is 61.6% according to the 4th National Survey of Risk Factors, higher than the 57.9% reported by the 3rd survey. (8) The results of our study show that 8 of 10 patients presenting with myocardial infarction have excess weight, with 50.1% and 29.2%, with BMI in overweight and obesity ranges, respectively. On admission, patients with excess weight are younger and have more cardiovascular risk factors (hypertension, dyslipidemia, diabetes and tobacco use). However, there are no significant differences in in-hospital complications or mortality, and the risk of bleeding is even lower. In this regard, obesity has been associated with

Table 1. Baseline characteristics of the population

	G1 (n = 605)	G2 (n = 1466)	G3 (n = 854)	p
BMI, (mean/SD)	23.2 ±1.5	27.3 ±1.4	34.0 ±4	<0.0001
Age (mean/SD)	63 ±12	61 ±12	60 ±11	<0.0001
Male gender, % (n)	72.2 (436)	83.0 (1218)	78.2 (669)	<0.001
Hypertension, % (n)	50.8 (307)	58.1 (851)	65.4 (559)	<0.001
Diabetes mellitus, % (n)	11.4 (69)	22.4 (329)	27.9 (239)	<0.0001
Dyslipidemia, % (n)	35.4 (214)	40.3 (591)	43.3 (370)	0.01
Smoking habits, % (n)	18.7 (113)	24.8 (364)	23.9 (204)	0.01
Previous AMI, % (n)	9.7 (57)	11.2 (158)	11.3 (92)	0.58
Previous CAD % (n)	10.6 (64)	13.0 (191)	14.0 (120)	0.14
Previous PCI, % (n)	8.8 (53)	9.7 (142)	10.8 (92)	0.44
Previous CABG, % (n)	1.1 (7)	2.1 (30)	1.6 (14)	0.35
Previous stroke, % (n)	2.1 (13)	2.0 (29)	1.5 (13)	0.63

SD: standard deviation; AMI: acute myocardial infarction; CABG: Coronary artery bypass graft surgery; CAD: coronary artery disease; PCI: percutaneous coronary intervention

Table 2. Clinical characteristics and reperfusion

	G1 (n = 605)	G2 (n = 1466)	G3 (n = 854)	p
Anterior MI on ECG, % (n)	47.0 (284)	46.1 (674)	47.2 (401)	0.48
Killip class A, % (n)	76.9 (465)	78.5 (1151)	75.7 (647)	0.27
Killip class D, % (n)	8.9 (54)	7.4 (108)	7.1 (61)	0.38
Fibrinolytic agents, % (n)	13.2 (80)	13.6 (199)	13.8 (118)	0.97
D-N time (minutes/IQR)	60 (30-120)	60 (30-110)	52 (30-118)	0.84
CA within 24 h (n=2335) % (n).	78.5 (474)	80.5 (1180)	79.6 (681)	0.57
Primary PCI, % (n)	84.6 (401)	85.2 (1006)	84.6 (576)	0.90
Failed PCI, % (n)	3.5 (14)	3.9 (39)	4.7 (27)	0.60
D-B time (minutes/IQR)	104 (60-180)	110 (60-188)	110 (60-210)	0.27
≥2-vessel disease on CA, % (n)	38.2 (181)	34.5 (407)	37.3 (254)	0.26
DES, % (n)	28.3 (171)	26.6 (390)	31.3 (855)	0.05
Severe left ventricular dysfunction on echocardiogram, % (n)	13.1 (79)	9.7 (141)	9.7 (83)	0.05
Antiplatelet therapy				
Clopidogrel, % (n)	72.5 (438)	74.3 (1089)	70.1 (606)	0.19
Ticagrelor, % (n)	16.2 (98)	16.9 (248)	18.8 (161)	0.36
Prasugrel, % (n)	8.3 (50)	7.8 (114)	9.3 (79)	0.46

IQR: interquartile range; D-N: door-to-needle; D-B: door-to-balloon; CA: coronary angiography; DES: drug-eluting stent; MI: myocardial infarction

several changes in the coagulation and fibrinolytic systems. Obese subjects have higher concentrations of fibrinogen, factor VII, factor VIII, von Willebrand factor, and PAI-1, and therefore, increased platelet adhesion than lean subjects. (9) Likewise, the fact that the incidence of bleeding is lower could also be an expression of an excess of bleeding in the population compared, namely patients with BMI < 25 kg/m^2. Low weight has been reported by Mehran et al. (10) as one of the main causes of increased risk of bleeding, as well as advanced age, female sex, diabetes mellitus and renal failure, among others.

The CRUSADE study (11) also identified some variables, such as age, female sex, diabetes and renal dysfunction in coronary syndromes associated with greater risk of bleeding during hospitalization and at long term follow-up.

Our data show that the rate of complications and in-hospital mortality in patients with excess weight does not differ from that of the other groups studied.

Some studies have reported lower long-term mortality in obese patients, which has been called "the obesity paradox", (5,12,13) since on the one hand it is a risk factor for certain conditions (heart failure, stroke and myocardial infarction) but on the other hand it seems to have a protective effect for major events once they have occurred. One of the largest reviews, involving 40 studies and 250 000 patients with coronary ar-

Table 3. In-hospital mortality

	G1 (n = 605)	G2 (n = 1466)	G3 (n = 854)	p
Mortality, % (n)	9.7 (59)	7.5 (110)	8.4 (72)	0.22
ReAMI, % (n)	1.6 (10)	1.4 (21)	2.1 (18)	0.46
Postinfarction angina, % (n)	5.1 (22)	3.5 (36)	3.6 (22)	0.87
Cardiogenic shock %, (n)	10.6 (64)	8.7 (128)	8.4 (72)	0.56
Heart failure, % (n)	15.4 (93)	12.1 (177)	14.5 (124)	0.08
Atrial fibrillation, % (n)	4.0 (24)	4.3 (63)	3.5 (30)	0.55
Stroke, % (n)	1.1 (7)	0.7 (63)	0.8 (7)	0.78
Total bleeding, % (n)	5.6 (34)	2.8 (41)	3.4 (29)	<0.001
Major bleeding, % (n)	1.1 (7)	0.5 (12)	0.3 (3)	<0.01
Minor bleeding, % (n)	2.1(13)	0.8 (12)	0.6 (5)	<0.001
Minimal bleeding, % (n)	2.3 (14)	1.5 (22)	2.5 (21)	0.09

AMI: Acute myocardial infarction

tery disease and followed for 3.8 years, showed that patients with BMI <18 kg/m^2 had higher mortality than normal patients, and that those with overweight and obesity had lower mortality than those considered normal. (14) Buchholz et al. (15) also reported significantly higher 1-year mortality in the group with normal BMI (9.2%) compared with obese patients (4.7%) and those with morbid obesity (4.6%) ($p < 0.001$). In their study, in a population > 6500 patients with myocardial infarction, underweight patients also had lower mortality than normal patients (6.1%).

The recently published START-ANTIPLATELET Italian registry (16) observed better one-year outcome in obese patients and showed higher rates of mortality, myocardial infarction, stroke and bleeding events in those with normal weight (15.1%) compared with overweight and obese patients (8.6% and 9.6%, respectively; $p = 0.004$).

This paradoxical performance of mortality in relation with BMI reported in different studies could be explained by the presence of confounders as age, or because perhaps BMI is not a good discriminator of body fat or, in fact, when patients without obesity or overweight are compared with other patients, those with underweight could be at greater risk, tipping the scale. Like our findings, other authors have not found any differences in mortality according to BMI either during hospitalization or at long term follow-up. (17, 18) In our study, only Killip class other than A, age and multi-vessel disease were independent predictors of mortality.

Study limitations

The ARGEN-IAM-ST registry includes cases voluntarily incorporated by different public and private institutions related with scientific societies; therefore, the data may not represent all myocardial infarction patients treated in centers other than those that participated in the registry.

Our data are limited to in-hospital mortality, so we cannot extrapolate our results to long-term follow-up.

CONCLUSIONS

Overweight and obese patients with myocardial infarction are younger and have higher prevalence of coronary risk factors, but they do not present more in-hospital complications or mortality than patients without these characteristics. In our study, only Killip class other than A, age and multi-vessel disease were independent predictors of mortality.

Conflicts of interest

None declared.

(See authors' conflict of interests forms on the web/Additional material.)

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