One-Year Prognosis Difference of Myocardial Infarction With or Without Coronary Obstruction in Developing Countries: Insights From the Moroccan Experience

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ABSTRACT

INTRODUCTION: The debate remains open as to the difference in prevalence of mortality and occurrence of acute events in patients with Myocardial infarction with non-obstructive coronary arteries (MINOCA) and others with Myocardial infarction with coronary arteries disease (MI-CAD).

METHODS: We conducted a 2-year retrospective study for patients admitted for Acute coronary syndrome (ACS) to analyze the clinical and prognostic characteristics of patients with MINOCA versus MI-CAD. We defined 1-year all-cause mortality as the primary outcome, and the secondary outcome as a composite of 1-year readmission for myocardial infarction or acute heart failure (AHF).

RESULTS: Our study included 1077 patients, 95.3% with MI-CAD and 4.7% with MINOCA. At admission, 71.1% patient were diagnosed STEMI and 28.9% with NSTEMI. The difference between the 2 groups was found on age ($P < .001$), hypertension, diabetes with consecutive P-values of .007 and .001, as well as Ejection fraction ($P < .001$). For the outcomes studied, the difference was significant between the 2 groups for all events, and MINOCA patients had a better prognosis than MI-CAD patients, with adjusted hazard ratios (HR) for 1-year mortality (HR = 0.601 $P = .004$), for readmission for ACS (HR = 0.662; $P = .002$) and for readmission for AHF (HR = 0.539; $P = .019$).

CONCLUSION: Despite the ambiguity in the genesis of MINOCA, the short- and long-term prognosis of these patients remains generally favorable.

KEYWORDS: MINOCA, MI-CAD, acute coronary syndrome, prognosis

Introduction

Myocardial infarction (MI) is pathologically described as myocardial cell death caused by persistent ischemia. As early as 10 to 15 minutes after the onset of ischemia, the first ultrastructural alterations can be seen, including depletion of cellular glycogen, relaxed myofibrils and disruption of the sarcolemma,[1] and using electron microscopy, mitochondrial abnormalities can be observed as early as 10 minutes after coronary occlusion, and are progressive.[2]

Based on histological, clinical, prognostic and treatment-related characteristics, MI can be divided into 2 types[3]: Myocardial infarction with coronary arteries disease (MI-CAD), which is defined as a myocardial infarction with significant hemodynamic obstruction of 1 or more coronary arteries (>50%),[4] and the Myocardial infarction with non-obstructive coronary arteries (MINOCA) is a disease with several causes that is characterized by clinical evidence of MI and angiographically normal or minimally obstructive coronary arteries (<50% stenosis),[5-8] and 10% of acute coronary syndrome (ACS) are caused by MINOCA.[9] In this work, we carried out an analysis of the clinical and prognostic characteristics of MINOCA versus MI-CAD.

Materials and Methods

Rationale and design of the study

A significant proportion of patients admitted with ACS with or without persistant ST-segment elevation have no significant coronary artery stenosis to explain the symptomatology, in which case we speak of myocardial infarction with no obstructive coronary artery (MINOCA). This is a recent entity and is still the subject of debate concerning the etiological work-up, in which cardiac MRI plays a pivotal role in recognizing the mechanism of ischemia, assessing the necrosis extent, and thus eliminating differential diagnoses such as myocarditis.[10,11] In addition, the short- and long-term prognosis of these patients is still a research topic.

To this end, we conducted a 2-year monocentric retrospective study in our cardiac intensive care unit (CICU) for patients admitted for ACS to analyze the clinical and prognostic characteristics of patients with MINOCA versus MI-CAD.
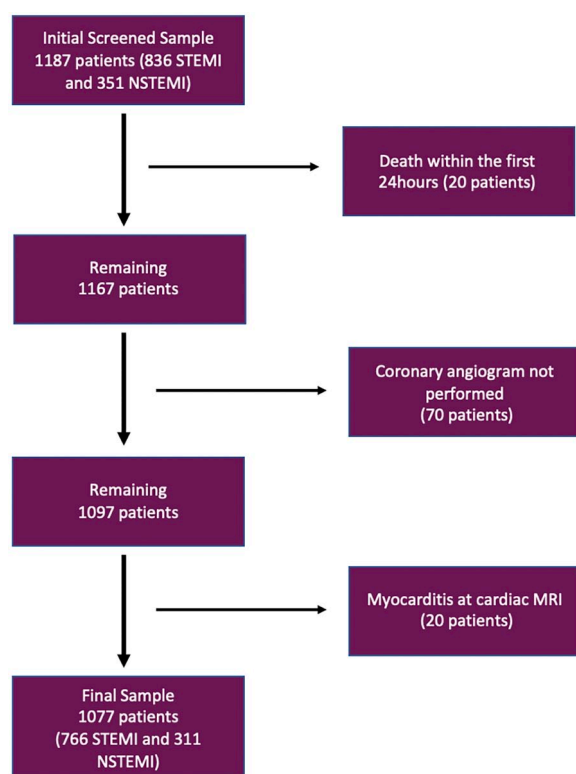
Figure 1. Flow diagram for study participations.

Study population and data collection

We included all patients admitted for ACS with or without ST-segment elevation and in who coronary angiography had been performed. We defined an ACS as a patient who presented with chest pain with presumed new ECG electrical changes, associated with positive troponin levels changes. We excluded patients who died before coronary angiography was performed, as well as patients who refused coronary angiography, and patients with myocarditis at cardiac Magnetic Resonance Imaging (MRI; Figure 1).

All demographic, clinical, echocardiographic, angiographic data, as well as intra-hospital evolution and the evolution during the follow-up were obtained from patients' electronic medical records.

Definition

• **STEMI**

We defined STEMI according to an association of chest pain presumed to be of coronary origin, with persistent ST-segment elevation or equivalent, and troponin elevation above 99 percentiles with coronary angiography occlusion or significant stenosis (>70% for coronary arteries and 50% for the left main).[12,13]

• **NSTEMI**

We defined NSTEMI as the association of chest pain of presumed coronary origin associated with dynamic ST-segment

changes, and troponin elevation above 99 percentiles with significant coronary artery occlusion or stenosis (>70% for coronary arteries and 50% for the left main).[14]

• **MINOCA**

We defined MINOCA as the association of chest pain presumed to be of coronary origin and troponin elevation above the 99th percentile with the absence of significant stenosis on coronary angiography, excluding myocarditis or tako-tsubo cardiomyopathy.[15,16]

• **Acute heart failure**

We defined AHF as any clinical presentation suggestive of left ventricular failure secondary to acute elevation of left ventricular filling pressures due to impaired systolic or diastolic function.[17]

Outcomes study

We defined 1-year all-cause mortality as the primary outcome, and the secondary outcome as a composite of 1-year readmission for ACS or acute heart failure (AHF).

Statistical analysis

The categorical variables were reported as numbers and percentages, then Pearson's chi-square test or Fisher's exact test were used for comparison between the different groups. For continuous variables, normality was first analyzed using the Shapiro-Wilk test, then the variables were reported as mean and standard deviation (SD) or median and interquartile range and compared using the *t*-student test or non-parametric tests depending on whether or not the distribution was normal.

The primary and secondary outcomes was studied using a Cox proportional hazards regression model to estimate hazard ratios (HRs) and 95% confidence intervals (CIs), adjusting for variables described in the literature. Kaplan-Meier analysis was used to compare mortality rates and readmission for ACS or AHF between the different groups, with significance between groups being assessed by the log-rank test (Mantel-Cox). All *P*-values were calculated using 2-sided tests, and *P*-values less than .05 were considered statistically significant. All statistical analyses were performed using IBM SPSS version 26 (SPSS, Inc., Chicago, IL).

Ethical approval

This study did not require formal ethics approval. Access to patient data was authorized by the Mohammed VI University Hospital and approved by the head of department, given the retrospective design of this study. The requirement for patient consent was waived. Data anonymity was respected in accordance with national and international guidelines.

Results

(A) General characteristics (Table 1)

Our study included 1077 patients, 95.3% with MI-CAD (1025 patients) and 4.7% with MINOCA (52 patients). Males predominated between the 2 groups, with a total percentage of 74.7%. The MINOCA group was significantly younger, with a mean age of 53.15 ± 13.86 years, than the MI-CAD group, with a mean age of 63.41 ± 10.17 years, with a significant difference ($P < .001$). There was no difference in length of hospital stay between the 2 groups, with an overall mean of 4 nights ± 2.18. For risk factors, arterial hypertension and diabetes were the 2 most frequent factors in our study, with consecutive percentages of 39.9% and 39.6%, with a significant difference between the 2 groups, with consecutive P-values of .007 and .001.

The mean time from onset of symptoms to presentation was 12.34 hours, with no difference between the 2 groups. On admission, 1.9% had a systolic blood pressure (SBP) < 90 mmHg, and 9.7% of patients had clinical signs of heart failure with a KILLIP class > II. For the admission diagnosis, 71.1% were considered STEMI and 28.9% NSTEMI. In the MINOCA group, 77% patients were considered STEMI and 23% patients NSTEMI.

On electrocardiography, persistent ST-segment elevation was found in 73.9%, ST-segment depression in 49.4%, and ST-segment elevation in AVR in 5.9%, with no difference between the 2 groups.

The mean ejection fraction calculated by trans-thoracic echocardiography was 47% in MINOCA and 53% in MI-CAD ($P < .001$). For left ventricular diastolic function, there was no difference between the 2 groups, and the same was observed for right ventricular systolic function.

In the MI-CAD group, the most frequent culprit artery was LAD (60.8%), followed by RCA (22%), LCX (15.4%) and LM (1.8%). Flow was restored in 525 patients, but 217 patients had TIMI 0 or TIMI I flow. Of these patients, PCI was performed in 742, surgery in 217, a conservative strategy in 66 and a pharmaco-invasive strategy in 245.

In the biological work-up, anemia (Hb < 10 g/dl) was found in 21.4%, inflammation with CRP > 300 mg/ml in 2.5%, with no significant difference for either parameter. However, acute kidney disease with (GFR < 30 ml/min/1.73 m^2 and white blood cell count > 12 000/mm^3) were different between the 2 groups.

As for the outcome during hospitalization, 8.1% had presented acute heart failure, 5.7% a threatening arrhythmia, 7.4% a threatening conduction disorder, 1.2% a mechanical complication, 3.2% cardiogenic shock, and finally 1.7% had died during hospitalization, with no significant difference between the 2 groups for any of these events.

(B) Outcomes study (Table 2)

For the primary outcome, 47 events were observed with a total percentage of 4.4%: 46 (4.6%) events in the MI-CAD group

and 1 (0.1%) event in the MINOCA group ($P < .001$). The Kaplein Meier survival analysis showed a significant difference between the 2 groups, with a log-rank test P-value of .023 (Figure 2).

For secondary outcomes, firstly, for readmission for ACS, 55 events were observed, that is, 5.1%: 54 events in the MI-CAD group (5%) and 1 event in the MINOCA group (0.1%) ($P = .002$), and for readmission for acute heart failure, 28 events were observed, that is, 2.6%: 27 events in the MI-CAD group (2.5%) and 1 event in the MINOCA group (0.1%) ($P = .042$). For the 2 secondary outcomes, the kaplein Meier analysis objective a significant difference between the 2 groups with consecutive log-rank test P-values of .033 and .035 (Figures 3 and 4).

Multivariable analysis (Table 3)

Using Cox proportional hazards analysis, we found, firstly before adjustment, that patients in the MINOCA group had a better prognosis than the MI-CAD group, for all-cause 1-year mortality (HR = 0. 442; 95% CI 0.227-0.760; $P = .041$), a lower risk of readmission for ACS (HR = 0.297; 95% CI 0.316-0.821; $P = .034$), as well as for readmission for AHF (HR = 0.555; 95% CI 0.329-0.836; $P = .045$).

After adjustment for age, arterial hypertension, diabetes, active smoking, EF < 40%, proximal LAD or LM as culprit artery, TIMI 0-I flow, CRP > 300 mg and KILLIP > 1 at admission, the results remained significantly in favor of a better prognosis for MINOCA: (HR = 0. 601; 95% CI 0.281-0.853; $P = .004$) for 1-year all-cause mortality, (HR = 0.662; 95% CI 0.398-0.809; $P = .002$) for readmission for ACS and finally (HR = 0.713; 95% CI 0.539-0.902; $P = .019$) for readmission for AHF.

Discussion

The debate remains open as to the difference in prevalence of mortality and occurrence of acute events in patients with MINOCA and others with MI-CAD.[18,19]

In a meta-analysis of 28 publications on this topic was published in 2015 by Pasupathy et al showed that the prevalence of MINOCA was 6%, with a median age of 55 years, and that 40% of them were women. Compared with MI-CAD. patients, MINOCA patients were more often young and female, and less often had dyslipidemia. However, other cardiovascular risk factors were similar between the 2 groups. After 12 months, the all-cause mortality rate was lower in the MINOCA group (4.7%, 95% CI, 2.6%-6.9%) than in the MI-CADgroup (6.7%, 95% CI, 4.3%-9.0%).[20]

In addition, as part of The ACUITY trial, Planer et al carried-out Propensity-Matched Analysis on 2422 patients diagnosed with SCA, of whom 2245 (91.9%) were with MI-CAD and 197 (8.1%) with MINOCA. For 1-month mortality, there was no difference between the 2 groups for all-cause mortality, but there was more recurrent myocardial infarction in the

Table 1. Showing the general characteristics of patients according to MINOCA or MI-CAD.

VARIABLES	ALL PATIENTS (1077)	MINOCA (52/1077)	MI-CAD (1025/1077))	*P* VALUE
Sex				
Male	805 (74.7%)	38 (73%)	767 (74.82%)	Ref
Female	272 (25.3%)	14 (27%)	258 (25.17%)	.41
Age	62.92 (10.60)	53.15 (13.86)	63.41 (10.17)	<.001
Length of stay (days) in CICU	4.04 (2.18)	3.87 (2.44)	4.05 (2.17)	.468
Cardiovascular risk factors				
Obesity	313 (29.1%)	13 (25%)	300 (29.26%)	.344
Android obesity	306 (28.4%)	14 (26.9%)	291 (28.4%)	.086
Arterial hypertension	430 (39.9%)	12 (23%)	418 (40.8%)	.007
Diabetes	427 (39.6%)	9 (17.3%)	418 (40.8%)	.001
Dyslipidemia	75 (7%)	2 (3.84%)	73 (7.12%)	.519
Active smoking	265 (24.6%)	15 (28.8%)	250 (24.39%)	.504
Chronic kidney disease	12 (1.1%)	0(0.0%)	12 (1.17%)	.132
Prior cardiovascular history				
Coronary artery disease	96 (9.4%)	0 (0.0%)	96 (9.3%)	.301
Heart failure	4 (0.4%)	2 (3.84%)	2 (0.2%)	.219
Arrhythmia	7 (0.6%)	1 (1.92%)	6 (0.1%)	.104
Severe valvular disease	8 (0.8%)	2 (3.84%)	6 (0.5%)	.158
Time from symptoms to consult (hours)	12.34 (19.4)	13.12 (17.91)	12.96 (18.31)	.197
Heart rate at admission	83.13 (18.68)	84.63 (20.42)	83.06 (18.59)	.553
SBP < 90 mmHg at admission	20 (1.9%)	1 (1.92%)	19 (1.85%)	.368
Cardiogenic shock at admission	8 (0.7%)	0 (0%)	8 (0.8%)	.672
KILLIP class at admission				
I-II	97 (9%)	1 (1.92%)	96 (9.36%)	.042
II	104 (9.7%)	3 (5.76%)	101 (9.85%)	.255
ACS presentation				
STEMI	766 (71.1%)	40 (77%)	726 (70.82%)	.507
NSTEMI	311 (28.9%)	12 (23%)	299 (29.17%)	.294
Electrocardiographic finding				
ST-elevation	796 (73.9%)	39 (75%)	757 (73.85%)	.405
ST depression	532 (49.4%)	32 (61.5%)	500 (48.78%)	.070
AVR ST-elevation	64 (5.9%)	1 (1.92%)	63 (6.14%)	.179
Echocardiographic findings				
EF at discharge	47.46 (11.55)	53.23 (12.08)	47.16 (11.45)	.001
LV systolic function				
Normal	535 (49.7%)	28 (53.84%)	507 (49.46%)	Ref
Mildly reduced	233 (21.6%)	10 (19.2%)	223 (21.75%)	.058

(Continued)

Table 1. (Continued)

VARIABLES	ALL PATIENTS (1077)	MINOCA (52/1077)	MI-CAD (1025/1077))	*P* VALUE
Reduced	309 (28.7%)	14 (27%)	295 (28.78%)	.08
LV diastolic function				
Normal	884 (82.1%)	44 (84.6%)	840 (81.95%)	Ref
Indeterminate	38 (3.5%)	4 (7.7%)	34 (18.04%)	.998
Dysfunction	155 (14.4%)	4 (7.7%)	151 (14.73%)	.562
RV systolic dysfunction	56 (5.2%)	3 (5.76%)	53 (5.17%)	.503
Coronarography findings				
LM	94 (8.7%)	-	94 (8.7%)	-
LAD	802 (74.5%)	-	802 (74.5%)	-
LCX	424 (39.4%)	-	424 (39.4%)	-
RCA	535 (49.7%)	-	535 (49.7%)	-
Culprit artery				
LM	19 (1.8%)	-	19 (1.8%)	-
LAD	622 (60.8%)	-	622 (60.8%)	-
LCX	158 (15.4%)	-	158 (15.4%)	-
RCA	226 (22%)	-	226 (22%)	-
Revascularization strategy				
Conservative strategy	66 (6.1%)		66 (6.1%)	
PCI	742 (68.9%)		742 (68.9%)	
Surgery	217 (20.2%)		217 (20.2%)	
TIMI flow pre-PCI				
TIMI 0-I	217 (21.17%)	-	217 (21.17%)	-
TIMI II or III	525 (51.21%)	-	525 (51.21%)	-
Vascular access				
Radial approach	1050 (97.4%)	52 (100%)	998 (97.36%)	-
Femoral approach	27 (2.6%)	0 (0%)	27 (2.45%)	
Number of implanted stents				
Drug-eluting balloon	41 (3.8%)	-	16 (1.56%)	-
1	470 (43.7%)	-	167 (16.29%)	-
2	168 (15.6%)	-	59 (5.75%)	-
>3	63 (5.7%)	-	20 (1.95%)	-
Biological findings				
Hb				
<10 g/dl	231 (21.4%)	12 (2.3%)	219 (21.36%)	0.441
GFR ml/min/1.73 m²				
<30	143 (13.3%)	2 (3.84%)	141 (13.75%)	**0.022**
CRP				

(Continued)

Table 1. (Continued)

VARIABLES	ALL PATIENTS (1077)	MINOCA (52/1077)	MI-CAD (1025/1077))	*P* VALUE
>300 mg/l	27 (2.5%)	2 (3.84%)	25 (24.39%)	0.532
WBC				
12 000/mm³	71 (6.5%)	1 (1.92%)	70 (68.29%)	**0.028**
Management in CICU				
Central venous access (CVA)	53 (4.9%)	2 (3.84%)	51 (4.97%)	**0.522**
Vasopressor or inotrope use	44 (4.1%)	1 (1.92%)	43 (4.19%)	0.360
Temporary pace-maker	13 (1.2%)	0(0.0%)	13 (1.26%)	0.418
Thrombolysis	245 (22.7%)	13 (25%)	232 (22.63%)	0.400
Evolution and complications				
Acute heart failure in-hospital	87 (8.1%)	2 (3.84%)	85 (8.29%)	0.191
Bleeding events	18 (1.67%)	0 (0%)	18 (1.75%)	0.005
Thrombosis events	46 (4.2%)	2 (3.84%)	44 (4.29%)	0.004
Life-threatening VA in-CICU	23 (5.7%)	12 (5.76%)	11 (1.07%)	0.069
Life-threatening CD in-CICU	30 (7.4%)	8 (15.38%)	22 (2.14%)	0.329
Mechanical complication in-CICU	5 (1.2%)	0 (0%)	5 (0.48%)	0.780
In-CICU cardiogenic shock	36 (3.2%)	1 (1.92%)	35 (3.41%)	0.472
In-hospital mortality	18 (1.7%)	1 (1.92%)	16 (1.56%)	0.407
Antithrombotic management at discharge				
Aspirine	87 (8.1%)	49 (94.23%)	963 (93.95%)	0.098
IP2Y12	23 (5.7%)	23 (46.93%)	923 (90.04%)	0.001
Anticoagulation	30 (7.4%)	3 (5.76%)	62 (6.04%)	0.09

Table 2. Shows the difference between the 2 groups for primary and secondary outcomes endpoints.

OUTCOMES	MI-CAD	MINOCA	*P* VALUE
Primary endpoint			
1-years mortality all causes	46 (4.3%)	1 (0.1%)	<**.001**
Secondary composite endpoint			
Readmission for ACS	54 (5%)	1 (0.1%)	**.002**
Readmission for AHF	27 (2.5%)	1 (0.1%)	**.042**

MI-CAD group (HR = 0.11 95% CI: 0.02, 0.82; *P* = .03). At 1 year, and paradoxically, overall mortality was significantly higher in the MINOCA group (5.2% vs 1.6%), with (HR = 3.44 95% CI: 1.05, 11.28 ; *P* = .04). Conversely, rates of recurrent myocardial infarction were significantly higher in patients with obstructive coronary artery disease (HR = 0.35 95% CI: 0.12, 0.98; *P* = .04).[21]

In a large meta-analysis that included 36 932 patients after the selection of 44 studies, with at least a follow-up duration of more than 6 months of patients with ACS. The duration of the study observation period was approximately 25 months, during which 1409 patients (3.8%) died, with an overall annual mortality rate of 2.0% (95% confidence interval [CI]: 1.5% to 2.4%), with significant heterogeneity (I^2 = 80%, *P* < .001). After analyzing 26 of the selected studies that compared MINOCA patients with those suffering from myocardial infarction and obstructive coronary disease, they concluded that annual long-term total mortality rates were 2.2% for MINOCA patients
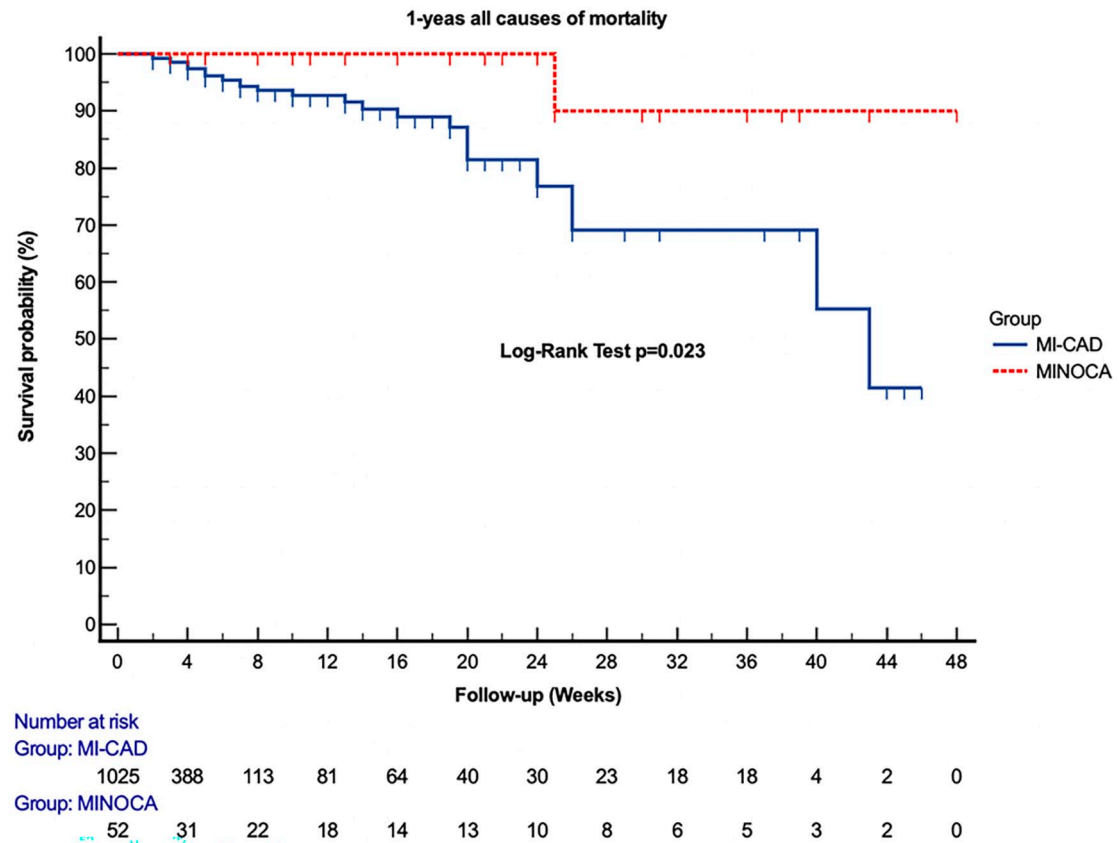
Figure 2. Kaplan-Meier curve for all-cause mortality at 1 years according to MINOCA or MI-CAD.
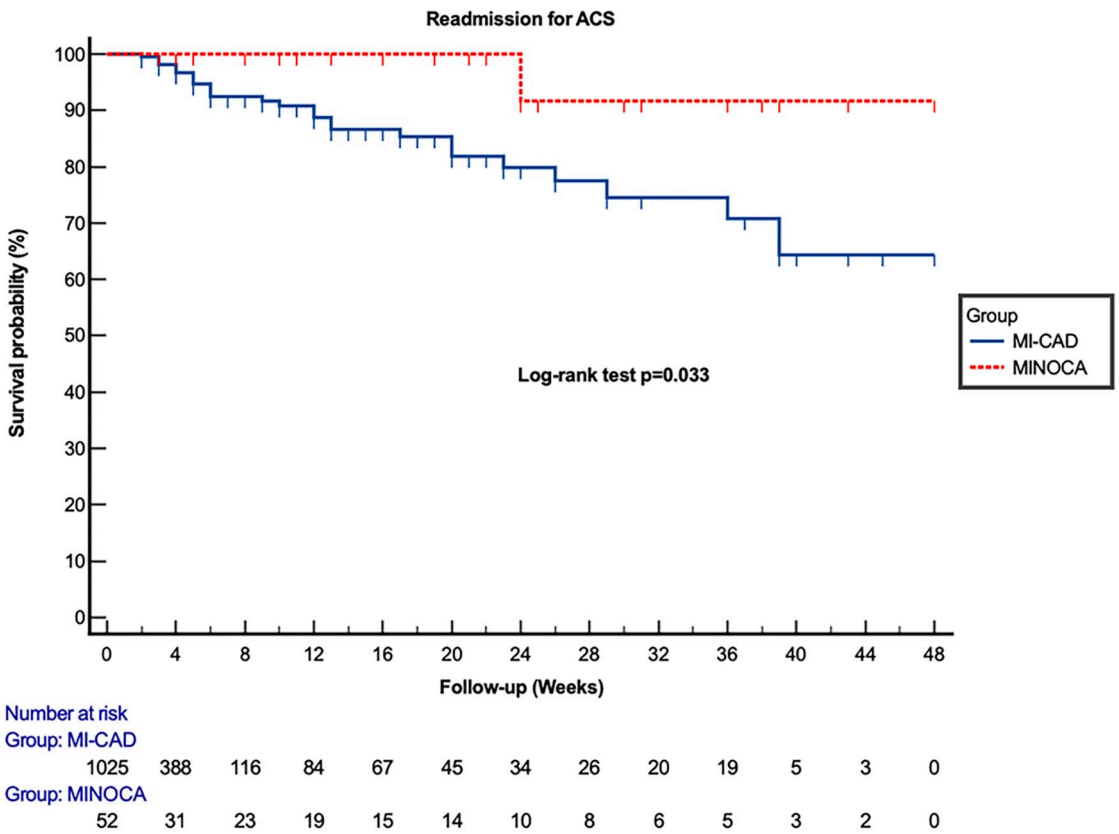

Figure 3. Kaplan-Meier curve for readmission for myocardial infarction at 1 years as a function of MINOCA or MI-CAD.
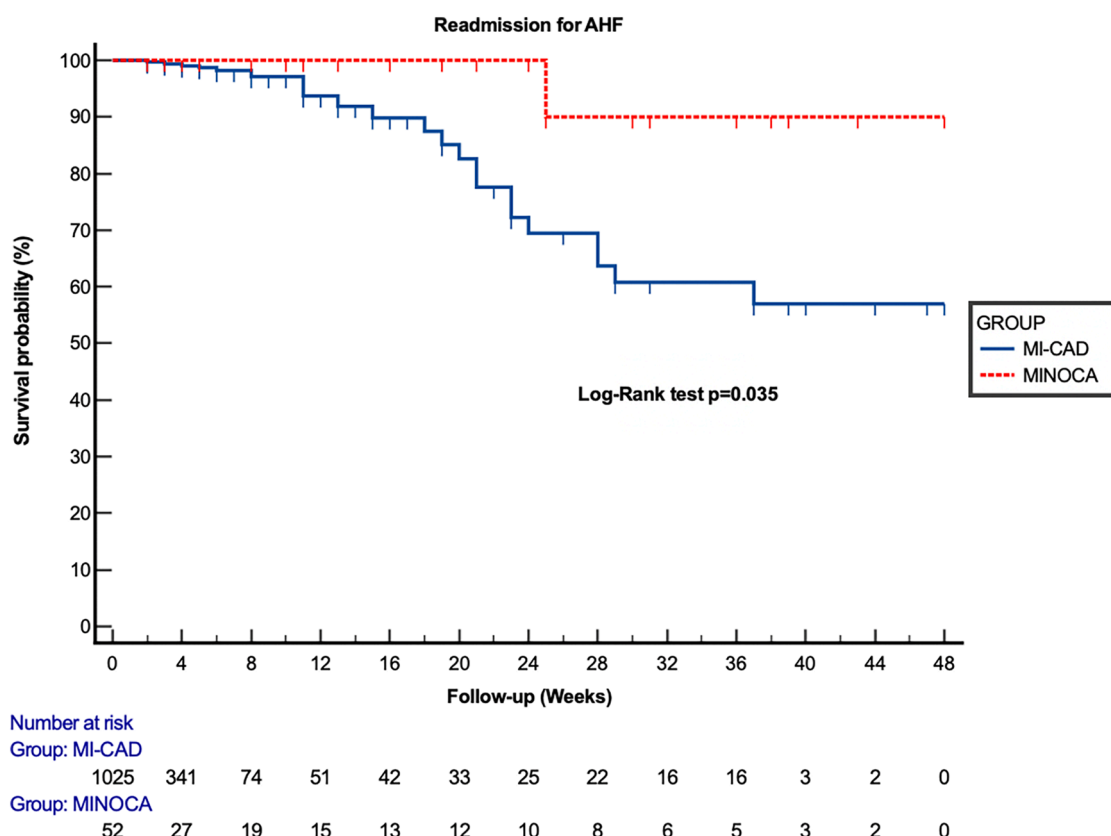
Figure 4. Kaplan-Meier curve for readmission for Acute heart failure at 1 years as a function of MINOCA or MI-CAD.

Table 3. Cox proportional hazards analysis for the different outcomes studied for the MINOCA group versus MI-CAD before and after adjustment for (Age, arterial hypertension, diabetes, active smoking, EF < 40%, proximal LAD or LM as culprit artery, TIMI 0-I flow, CRP >300 mg and KILLIP >I at admission).

OUTCOMES	UNADJUSTED HAZARD RATIO (HR)			ADJUSTED HAZARD RATIO (HR)		
	HR	95% CI	*P* VALUE	HR	95% CI	*P* VALUE
1-years all causes of mortality	0.442	0.227 ; 0.760	.041	0.601	0.281 ; 0.853	.004
Readmission for ACS	0.297	0.316; 0.821	.034	0.662	0.398; 0.809	.002
Readmission for AHF	0.555	0.329 ; 0.836	.045	0.713	0.539; 0.902	.019

and 5.0% for patients with obstructive coronary disease, with a significant difference (relative risk: 0.60, 95% CI: 0.46-0.78, *P* < .001). In addition, a meta-regression analysis showed that long-term mortality correlated directly with beta-blocker use during the follow-up period and the presence of ST-segment depression on the admission electrocardiogram, and inversely with normal ejection fraction and normal coronary arteries on angiography.[22]

With the same objective of our study, Dreyer et al analyzed patients with MINOCA from the National Cardiovascular Data Registry (NCDRVR) CathPCI Registry, and among a total of 276 522 patients admitted for ACS 16 849 (5.9%) had MINOCA. The primary endpoint was major adverse cardiac events (MACE) defined as all-cause mortality, re-hospitalization for acute myocardial infarction (AMI), heart failure (HF) or stroke 12 months after AMI, and secondary endpoints included 12-month MACE components. Results showed that 12-month MACE rates (18.7% vs 27.6%) were significantly lower for MINOCA patients than for MI-CAD patients (*P* < .001). For the secondary endpoints, the rates of mortality (12.3% vs 16.7%), re-hospitalization for HF (5.9% vs 9.3%) and re-hospitalization for AMI (1.3% vs 6.1%), were always significantly lower for MINOCA versus MI-CAD. patients (*P* < .001). In multivariate analysis and after risk adjustment, MINOCA patients had a lower mortality rate than MI-CAD patients (*P* < .001). MINOCA patients had a lower risk of MACE (HR = 0.57, 95% CI 0.55-0.59), 12-month mortality after discharge (HR = 0.60, 95% CI 0.57-0.63) and a low rate of re-hospitalization for HF or AMI (HR = 0.89; 95% CI 0.86-0.91).[23]

In another sense, and to determine the factors predictive of an unfavorable outcome in patients with MINOCA, Nordenskjöld et al conducted a 10-year observational study of 199 163 patients admitted for AMI. For MACEs defined as all-cause mortality, rehospitalization for acute infarction, ischemic stroke and heart failure, and after risk adjustment, the predictive factors found were advanced age, hypertension, diabetes, previous myocardial infarction or stroke, active smoking, peripheral vascular disease, reduced left ventricular ejection fraction, higher creatinine and lower total cholesterol levels, and for all-cause mortality, the independent predictive factors are almost the same as those for MACEs, in addition to the high level of CRP (C-reactive protein), and after the results of this analysis, we can deduce the similarity between the predictive factors of unfavorable evolution between MINOCA and MI-CAD.[24] And since patients with CAD-MI complicated by cardiogenic shock on admission are characterized by high short- and long-term mortality,[25-27] KILLIP stage 1 was independently associated with high mortality, with a 3-fold higher risk of mortality ($P = .001$) and a 4-fold higher risk of hospitalization for heart failure ($P = .003$) in patient admitted for MINOCA.[3]

To summarize, MINOCA remains an entity in its own right, and not negligible among patients admitted for ACS whose long-term prognosis is better than patients with MI-CAD,[28] although the predictive factors of an unfavorable outcome are almost similar, but the major difference in the pathophysiology of the 2 entities may explain this difference in prognosis.[29]

Study Limitations

Our study has 3 main limitations: firstly, its observational nature; secondly, the number of patients included, although 1077 patients is a large number, it would be just as well to have a larger number, especially given the observational nature of the study; and thirdly, the limited follow-up time of 1 year. But despite these limitations, our results are very similar to those published in the literature.

Conclusion

MINOCA remains an entity of recent description, and its pathophysiological mechanisms are still the subject of debate, but despite this ambiguity, the prognosis of these patients in the short and long term remains generally favorable.

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None

Author Contributions

A.B. developed the project idea, writing and revising the proofs.
M. I. writing and revising the proofs.
Z. B., N.I., and N.E. supervised the project.

All authors contributed to the article and approved the submitted version.

Data Availability Statement

The data underlying this article are available in the article and in its online supplementary material.

Ethical Approval

Not required

Consent to Publication

Not required

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