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Prevalence, Clinical Features, Treatment, and Outcomes in Patients With Myocardial Infarction With Non-Obstructive Coronary Arteries

Aim	To study clinical and demographic characteristics, treatment options, and clinical outcomes in patients with myocardial infarction with non-obstructive coronary arteries (MINOCA) compared with patients with myocardial infarction with obstructive coronary arteries (MIOCA).
Material and methods	This single-center prospective observational study included 712 successive patients diagnosed with acute myocardial infarction (MI), who routinely underwent direct coronary angiography. Based on the presence of stenosing coronary atherosclerosis, the patients were divided into two groups: MIOCA (coronary stenosis ≥50%) and MINOCA (coronary stenosis <50% without other, alternative causes). Clinical outcomes included in-hospital and long-term overall mortality, and cardiovascular rehospitalization. The median follow-up was 1.5 years.
Results	MINOCA was diagnosed in 73 (10.3%) patients, 37 (50%) of whom were women. The median age of patients with MINOCA was 61 years and in the MIOCA group 65 years. No significant differences in cardiovascular risk factors were found between patients with MINOCA and MIOCA. In 53.4% of cases, the cause of MINOCA was a discrepancy between the myocardial oxygen demand and supply, and in 35.6% of cases, the cause was hypertensive crisis and pulmonary edema. The factors associated with MINOCA included an age ≤58 years, female gender, absence of the ST-segment elevation, absence of areas of impaired local contractility, and presence of aortic stenosis and bronchopulmonary infection. Patients with MINOCA were less likely to be prescribed acetylsalicylic acid, P2Y12 inhibitors, dual antiplatelet therapy, beta-blockers, and statins (p<0.05). Data on long-term outcomes were available for 87.5% of patients (n=623). The prognosis of patients with MIOCA was comparable for in-hospital mortality (1.5% vs. 6.2%; p=0.161) and long-term overall mortality (6.1% vs. 14.7%; p=0.059). Cardiovascular rehospitalizations were more frequent in the MINOCA group (33.3% vs. 21.5%; p=0.042).
Conclusion	The prevalence of MINOCA in our study was 10.3% among all patients with acute MI. MINOCA patients had comparable generally recognized cardiovascular risk factors with MIOCA patients. MINOCA patients had a comparable prognosis for in-hospital and long-term mortality and more often required cardiovascular rehospitalization.

Keywords	Myocardial infarction with non-obstructive coronary arteries; myocardial infarction with obstructive coronary arteries; clinical features; outcomes
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Introduction

Myocardial infarction with non-obstructive coronary arteries (MINOCA) is defined as the presence of signs and symptoms indicative of myocardial ischemia in the absence of significant coronary artery stenosis as determined by direct digital coronary angiogram (CAG) (coronary artery stenosis ≤ 50%) [1]. In the absence of an appropriate hemodynamically significant coronary artery stenosis, myocardial ischemia in patients with MINOCA may be caused by other pathological conditions of epicardial coronary arteries, including distal embolism by fragments of collapsed atherosclerotic plaque, coronary artery dissection or prolonged spasm. Additionally, coronary microcirculatory disorders, such as microvascular coronary dysfunction or material embolism from the aorta or cardiac cavities, may also contribute to this condition [2, 3].

It is imperative to ascertain whether MINOCA represents a discrete clinical entity with distinctive pathophysio-

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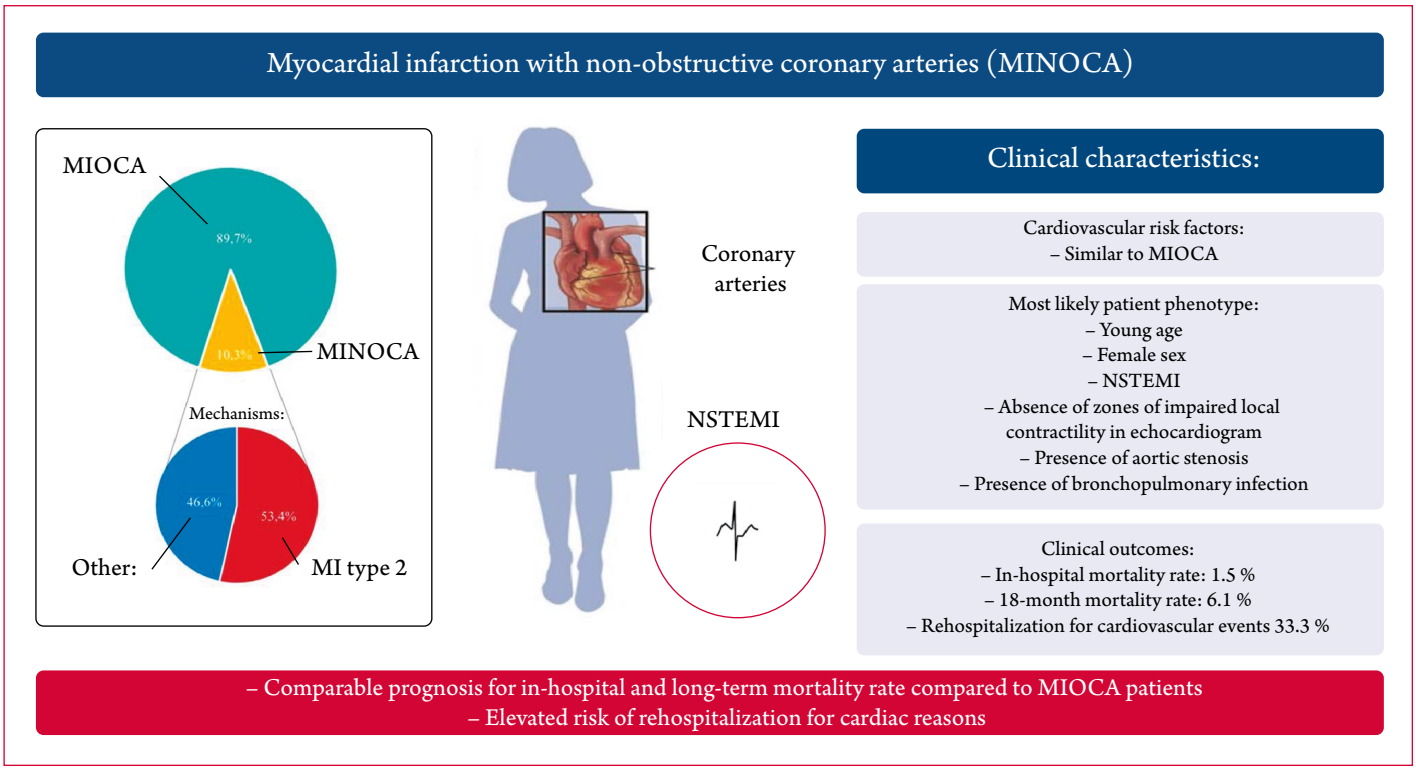
Central illustration. Prevalence, Clinical Features, Treatment, and Outcomes in Patients With Myocardial Infarction With Non-Obstructive Coronary Arteries



MI, myocardial infarction; MINOCA, myocardial infarction with non-obstructive coronary arteries; NSTEMI, non-ST-segment elevation myocardial infarction; MIOCA, myocardial infarction with obstructive coronary arteries.

logic mechanisms, clinical manifestations, and outcomes, as well as to develop an efficacious treatment strategy for these patients. Secondary prevention of myocardial infarction with obstructive coronary arteries (MIOCA) is not always an effective strategy for patients with MINOCA. Although patients with MINOCA are likely to have a more favorable long-term prognosis compared to patients with MIOCA, this does not necessarily guarantee the expected favorable prognosis [4–6].

In May 2016, the European Society of Cardiology published guidelines for the diagnosis and treatment of MINOCA [1], which have significantly enhanced our understanding of this diverse clinical condition. Nevertheless, the corpus of Russian literature on MINOCA remains comparatively limited, with only sporadic publications to date.

Objective

The objective of this study was to examine the clinical and demographic characteristics, treatment options, and clinical outcomes in patients with MINOCA in comparison to patients with MIOCA.

Material and Methods

A single-center prospective observational study was conducted, including 712 consecutive patients with acute myocardial infarction (MI) who underwent a mandatory CAG within the first 24 hours of onset between January 2017 and December 2018. Direct digital CAG was conducted via transradial access in the department of radiosurgical diagnosis and treatment at V. V. Vinogradov City Clinical Hospital (Moscow, Russia). The diagnosis of MI was made in accordance with the third universal definition [7].

The patients were divided into two groups based on the results of the direct CAG examination. The first group consisted of patients with MINOCA, defined as the presence of coronary artery stenosis equal to or exceeding 50% of the arterial diameter. The second group included patients with MIOCA, characterized by a narrowing of the coronary artery lumen to less than 50% or the absence of any stenosis. The study did not include patients with absolute contraindications to coronary angiography with iodine-containing contrast administration. Patients presenting with type 3, 4, or 5 MI and exhibiting signs of myocarditis or Takotsubo cardiomyopathy were excluded from the study. In cases where myocarditis onset simulates acute coronary syndrome (ACS), a differential diagnosis between acute MI and acute myocarditis was conducted. This was accomplished through a comprehensive assessment of the clinical manifestations, laboratory data, and the

rate of decline in troponin I levels. In the majority of cases, patients with myocarditis, in contrast to ACS, are distinguished by a slower decline in troponin levels [8].

The medical records of all patients were subjected to a comprehensive analysis, with particular attention paid to the following factors: clinical and demographic characteristics, anamnestic data, and findings of the physical examination at admission; results of laboratory tests and clinical investigations; as well as the specifics of therapy at discharge. To evaluate the severity of comorbidities, the Charlson Comorbidity Index was utilized [9], which has been validated in patients with ACS [10–12]. The GRACE 2.0 scale was used for the purpose of risk stratification in patients with MI [13].

Identification of the trigger factors that cause an imbalance between myocardial oxygen demand and delivery. The specific criteria for triggers were applied with the utmost rigor, in accordance with the standards set forth in previously published works on type 2 MI [14–16] (see the supplementary materials on the journal's website in Appendix 1).

Patient follow-up and endpoints. Adverse clinical outcomes were examined at multiple time points: at the time of admission, six months post-discharge, at the conclusion of the first year, and at the end of the second year following discharge, using structured telephone interviews with patients and/or their immediate family members. The median follow-up period was 1.5 (1.0–2.2) years. The primary endpoints were in-hospital mortality and all-cause mortality. The secondary endpoints were rehospitalization to a cardiac hospital and a combination of total cardiovascular events, including recurrent MI, stroke, and rehospitalization for a cardiac cause.

The study was conducted in accordance with the ethical standards set forth in the Declaration of Helsinki and received approval from the Ethics Committee of the Medical Institute of the Peoples' Friendship University of Russia (minutes #6 dated November 9, 2016). All patients provided written informed consent to participate in the study.

Statistical analysis

The statistical data processing was conducted using SPSS Statistics, version 22.0 (SPSS Inc., Chicago, IL, USA). Quantitative variables with a normal distribution are presented as mean ± standard deviation. Non-normally distributed quantitative variables are presented as median (Me) and interquartile range (IQR). Categorical data were compared using the Yates' chi-squared test or Fisher's exact test. To analyze differences in quantitative variables, Student's t-test (for normally distributed data), the nonparametric Wilcoxon test (for non-normally distributed data), or the nonparametric Friedman test were employed Univariate and multivariate logistic regression analyses were conducted for each variable to ascertain the odds ratio (OR), 95% confidence interval (CI), and statistical significance in relation to MINOCA. Furthermore, ROC curves were plotted for the MINOCA models to assess the area under the curve, 95% confidence interval, significance, sensitivity, and specificity. The threshold for statistical significance was set at $p < 0.05$.

Results

Principal characteristics

Of the 712 patients with MI included in the study, 73 (10.3%) were diagnosed with MINOCA. Table 1 presents a summary of the differences in clinical and demographic characteristics between patients with MINOCA and MIOCA.

The median age of patients in the MINOCA group was 61 (53; 70) years, compared to 65 (56; 74) years in the MIOCA group, with a p-value of 0.004. The proportion of female patients in the MINOCA group was higher than that in the MIOCA group (37 (50%) vs. 241 (37.7%), $p = 0.042$). The prevalence of cardiovascular diseases and comorbidities did not differ between the compared groups, with the exception of cancer, which was more prevalent in the MINOCA group (8 (10.5%) vs. 19 (3.0%), $p = 0.004$). Patients with MINOCA had a significantly lower Charlson Comorbidity Index score of 3 (2; 5) compared to 4 (3; 6) ($p = 0.001$).

The prevalence of chest pain was observed to be lower in patients with MINOCA than in those with MIOCA. Conversely, dyspnea and syncope were more common in the MINOCA group in comparison to the MIOCA group. No statistically significant differences were observed in systolic blood pressure (SBP), heart rate (HR), or the incidence of acute left ventricular failure between the two groups.

In regard to laboratory tests, the MINOCA group exhibited lower concentrations of total cholesterol, triglycerides, low-density lipoprotein cholesterol, and glucose, while displaying higher concentrations of high-density lipoprotein cholesterol (all $p < 0.05$). No statistically significant differences were observed in other parameters, including hemoglobin, troponin, and creatinine levels, between the two groups.

The occurrence of ST-segment elevation was less common in the MINOCA group, whereas left bundle branch block (LBBB) was more prevalent. As demonstrated by echocardiographic data, the left ventricular ejection fraction (LVEF) was observed to be higher in patients with MINOCA (54% vs. 44%, $p < 0.001$). The incidence of zones of hypo/akinesia was significantly higher in the MINOCA group. Aortic stenosis and pulmonary

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Table 1. Clinical and laboratory characteristics of patients with MINOCA and MIOCA

Parameter	MINOCA (n = 73)	MIOCA (n = 639)	P
Age, years	61 (53; 70)	65 (56; 74)	0.004
Female, n (%)	37 (50)	241 (37.7)	0.042
History of hypertension, n (%)	64 (87.7)	570 (89.2)	0.692
History of MI, n (%)	14 (19.2)	141 (22.1)	0.655
History of revascularization, n (%)	6 (8.2)	79 (12.4)	0.444
Diabetes mellitus, n (%)	14 (19.2)	136 (21.3)	0.763
CVA/TIA, n (%)	6 (8.2)	45 (7.0)	0.636
History of atrial fibrillation, n (%)	9 (12.3)	64 (10)	0.541
Cancer, n (%)	8 (10.5)	19 (3)	0.004
Charlson comorbidity index, score	3 (2; 5)	4 (3; 6)	0.001
Chest pain	58 (79.5)	600 (93.9)	< 0.001
Dyspnea	20 (27.4)	104 (16.3)	0.022
Syncope	5 (6.8)	12 (1.9)	0.023
SBP, mm Hg	140 (120; 170)	140 (120; 156)	0.195
HR, bpm	80 (68; 90)	76 (68; 88)	0.229
AHF Killip II–IV, n (%)	19 (26)	141 (22.1)	0.46
Troponin, ng/mL	0.24 (0.1; 1.07)	0.41 (0.09; 3.04)	0.221
Hemoglobin, g/L	136 (124.2; 142.7)	136 (122; 147)	0.676
Glucose, mmol/L	6.0 (5.5; 7.2)	7.0 (5.8; 9.5)	< 0.001
Creatinine, μmol/L	91 (79.5; 111)	93 (80; 107)	0.958
Total cholesterol, mmol/L	4.9 (3.7; 5.6)	5.2 (4.4; 6.1)	0.002
ST-segment elevation, n (%)	10 (13.7)	330 (51.6)	< 0.001
Atrial fibrillation in ECG, n (%)	12 (16.4)	85 (13.3)	0.471
LBBB, n (%)	11 (15.1)	41 (6.4)	0.015
LVEF, %	54 (43.5; 56)	44 (40; 50)	< 0.001
Hypokinesia/akinesia zones, n (%)	24 (32.9)	425 (66.5)	< 0.001
Aortic stenosis, n (%)	8 (10.9)	29 (4.5)	< 0.001
Pulmonary hypertension, n (%)	35 (47.9)	176 (27.5)	0.001
GRACE, score	112 (89.5; 131.5)	117 (98; 141)	0.053
Triggers, n (%)	39 (53.4)	285 (44.6)	0.173
Hypertensive crisis/pulmonary edema, n (%)	26 (35.6)	151 (23.6)	0.031
Tachyarrhythmia, n (%)	12 (16.4)	85 (13.3)	0.471
Bradyarrhythmia, n (%)	1 (1.4)	23 (3.6)	0.499
Anemia, n (%)	4 (5.5)	62 (9.7)	0.292
Bronchopulmonary infection, n (%)	8 (11)	30 (4.7)	0.047

The data are presented as median and interquartile range (Me (25%;75%)) and the number of patients (n (%)); AH, arterial hypertension; LBBB, left bundle branch block; MI, myocardial infarction; CVA, cerebrovascular accident; AHF, acute heart failure; SBP, systolic blood pressure; TIA, transient ischemic attack; LVEF, left ventricular ejection fraction, HR - heart rate.

hypertension were more common in the MINOCA group. Compared to the MIOCA group, MINOCA patients had more triggers, the most common being hypertensive crisis and bronchopulmonary infection.

Therapy at discharge

The prescription of beta-blockers, acetylsalicylic acid drugs, P2Y12 receptor antagonists, dual antiplatelet therapy, and statins at the time of discharge was less frequent in patients with MINOCA. Nevertheless, the frequency of prescription of renin-angiotensin system blockers was comparable between the two groups (Figure 1).

Table 2. Outcomes in MINOCA and MIOCA

Parameter	MINOCA (n = 66)	MIOCA (n = 557)	P
In-hospital mortality, n (%)	1 (1.5)	35 (6.2)	0.161
Total mortality, n (%)	4 (6.1)	82 (14.7)	0.059
Rehospitalization for cardiovascular events, n (%)	22 (33.3)	120 (21.5)	0.042
General cardiovascular events, n (%)	25 (37.9)	190 (34.1)	0.584

MINOCA, myocardial infarction with non-obstructive coronary arteries; MIOCA, myocardial infarction with obstructive coronary arteries.

Clinical outcomes

A total of 36 (5.1%) patients died during the course of their hospitalization. Data were available for analysis during the specified follow-up period for 623 (87.5%) of the 712 patients. The all-cause mortality rate was 13.8% (n = 86). A total of 142 (22.8%) patients were readmitted to the cardiology department, while 215 (34.5%) patients experienced a general cardiovascular event.

A trend toward reduced in-hospital and all-cause mortality was observed in patients with MINOCA (Table 2). Patients with MINOCA exhibited an increased likelihood of hospital readmission due to cardiovascular events. No significant discrepancies were observed in the patterns of general cardiovascular events between the groups.

Factors associated with MINOCA

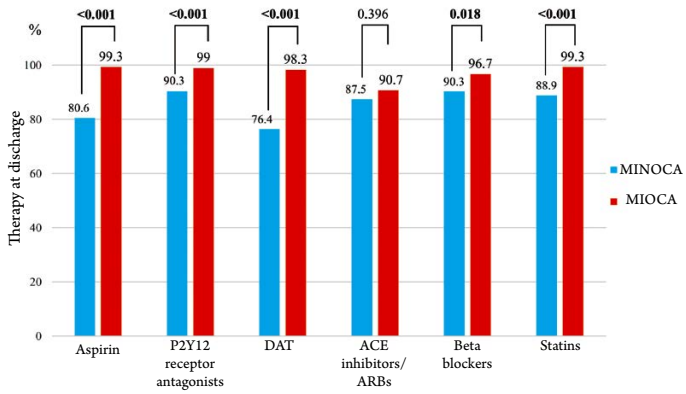
The results of the univariate and multivariate log-rank regression analyses examining factors associated with MINOCA are presented in Appendix 2 (see the supplementary materials on the journal's website). The independent factors associated with MINOCA were found to be age ≤ 58 years (OR 1.04; 95% CI: 1.0–1.07, p = 0.032), female sex (OR 2.29, 95% CI: 1.25–4.21, p = 0.008), the absence of ST segment elevation in ECG (OR 4.72; 95% CI: 2.22–10.04, p < 0.001), the absence of contractility zones in echocardiogram (OR 3.10; 95% CI: 1.48–6.48, p = 0.003), the presence of aortic stenosis (OR 2.97; 95% CI: 1.07–8.24, p = 0.036), and the presence of bronchopulmonary infection (OR 3.74, 95% CI: 0.97–1.05; p = 0.022)

The area under the ROC curve of the log regression model is 0.82 (95% CI: 0.77–0.87, p < 0.001), with a sensitivity of 81.6% and a specificity of 71.2% (see Appendix 3 in the supplementary materials on the journal's website).

Discussion

As documented in the literature, the prevalence of MINOCA in patients with MI is estimated to be between 3% and 15% [6, 17]. The prevalence of MINOCA in the Russian Federation, as determined by various studies, ranges from 4.1% to 14.5% [18–22]. The prevalence of MINOCA in our study was 10.3%, which is higher than the recently published data from a meta-analysis of clinical trials (approximately 6%) [4]. The discrepancy in the reported incidence of MINOCA across studies can be attributed to variations in the study populations and the lack of consensus on their identification [5, 23–25]. Moreover, the absence of ST-segment elevation on ECG was more prevalent in patients with MINOCA, which was consistent with the findings of previous studies [4, 26].

Figure 1. Therapy at discharge in patients with MI with non-obstructive coronary arteries and in patients with MI with obstructive coronary arteries



ARB, angiotensin II receptor blocker; DAT, dual antiplatelet therapy; ACE, angiotensin-converting enzyme; MINOCA, myocardial infarction with non-obstructive coronary arteries; MIOCA, myocardial infarction with obstructive coronary arteries.

Patients with MINOCA may be younger in age, with a higher proportion of women, and with fewer comorbidities [4, 6, 17, 27, 28]. These findings indicate the possibility of hormonal factors contributing to the development of MINOCA. Nevertheless, further research is required to address this issue.

In the current study, we undertook a comparison of the prevalence of cardiovascular risk factors and comorbidities between patients with MINOCA and MIOCA. Our findings indicate that MINOCA is not a benign condition and suggest a potential association between its underlying pathology and the presence of atherosclerosis and thrombosis [22, 28]. The data indicated that patients with MINOCA exhibited lower Charlson Comorbidity Index values, suggesting a reduced prevalence of comorbidities within this group. It is noteworthy that the incidence of cancer was even higher in the MINOCA group. This can likely be attributed to the age of the MINOCA patients, who exhibited a higher Charlson index [29]. Although some of these characteristics have been previously described in other studies, they have not been sufficiently addressed in the Russian literature.

The present study demonstrated that the trigger factors that cause an imbalance between myocardial oxygen demand and delivery to the myocardium in type 2 MI are more frequent in patients with MINOCA. The most common cause is a hypertensive crisis or pulmonary edema. It is of the utmost importance to take these triggers into account treating MINOCA. Additionally, the presence of bronchopulmonary infections was identified as a factor associated with MINOCA. The elevated incidence of bronchopulmonary infections may be attributable to asymptomatic or atypical myocarditis [30]. Some studies

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have identified an association between community-acquired pneumonia and the development of type 2 MI [31–34]. An elevated concentration of proinflammatory cytokines may contribute to endothelial dysfunction and/or atherosclerotic plaque instability, thereby increasing the risk of developing both type 2 and type 1 MI. In a recent prospective study by Putot et al. [33], which examined 4,573 patients with MI, 466 (10%) patients had a concomitant acute infection. Of these, 313 (67%) patients had a bronchopulmonary infection. Type 2 MI was identified in 72% of MI cases that occurred subsequent to an infectious disease. Moreover, the authors identified a correlation between the presence of infection and an elevated risk of in-hospital mortality (11% vs. 6%, $p < 0.001$, respectively) [33].

Aortic stenosis has been proposed as a potential trigger for an imbalance between myocardial oxygen demand and delivery in type 2 MI [35–39]. In a multicenter, population-based prospective study comprising 4,572 patients hospitalized in the intensive care unit, 862 (19%) patients were diagnosed with type 2 MI, and aortic stenosis was identified as a trigger of type 2 MI in 10% of patients [36].

Given the heterogeneity of the pathological mechanisms underlying MINOCA, it is possible that the conventional approach to secondary prevention of MI may prove ineffective for all patients with MINOCA. Some studies have indicated that patients with MINOCA are less likely to receive specific conventional secondary prevention therapy [40, 41]. Similarly, our study demonstrated that patients with MINOCA were less likely to receive prescriptions for acetylsalicylic acid, P2Y12 inhibitors, dual antiplatelet therapy, beta-blockers, or statins at the time of discharge. This is presumably due to the absence of evidence-based therapy recommendations for this specific population. Prior research has indicated that beta-blockers and dual antiplatelet therapy may be less effective in reducing the risk of new cardiovascular events in patients with MINOCA [42]. Conversely, statins and renin-angiotensin system blockers have been shown to have a potentially beneficial effect. Other studies have demonstrated that low-dose acetylsalicylic acid medications are ineffective in preventing future cardiovascular events in patients with MINOCA [43]. It is recommended that antiplatelet therapy be considered for patients with MINOCA who present with inflammatory deformation and fragmentation of atherosclerotic plaques [42].

Prior research has indicated that the mortality rate among hospitalized patients with MINOCA is relatively low. In the course of our study, we observed a 1 (1.4%) case of in-hospital mortality, occurring in one of the 73 patients enrolled. The ACTION-GWTG study demonstrated a comparable in-hospital mortality rate of 1.1% in 19,000 patients with MINOCA [44]. In the SWEDEHEART study, the long-term mortality rate was 13.4%, recurrent MI occurred in 7.1% of patients, and repeat hospitalization for cardiac events occurred in 10% of patients with MINOCA, with a mean follow-up period of 4.1 years [42]. The long-term mortality rate observed in our study was 13.8%, which is consistent with the findings of the SWEDEHEART study. Furthermore, the incidence of recurrent hospitalization for cardiac events was markedly elevated in patients with MINOCA in comparison to those with MIOCA (33.3% vs. 21.5%, respectively). However, a previous study demonstrated that the rate of all-cause rehospitalization in MINOCA patients was comparable to that observed in MIOCA patients (28.8% vs. 30%, respectively) [45], which is inconsistent with our findings. In conclusion, it is imperative to recognize that MINOCA is not a benign condition. The identification of the various characteristics and underlying causes of MINOCA is of the utmost importance for the selection of appropriate treatment and effective prevention strategies.

Limitations

There are several limitations to this study. First, a broad definition of MINOCA was employed, encompassing patients who were suspected to have this syndrome. Furthermore, the recently published fourth universal definition of MI [46] modifies the context of acute MI with regard to the definition of MINOCA. Secondly, it should be noted that our study is observational in nature, and 12.5% of patients were lost to follow-up, which may limit the completeness of the information available and may affect the reliability of the assessment of clinical outcomes. Thirdly, the inability to perform cardiac magnetic resonance imaging, intracoronary imaging, intravascular manometry, and Doppler imaging, as well as the inability to perform the coronary artery spasm challenge test, may have an impact on the results of the study.

Conclusion

The present study demonstrated that the incidence of MINOCA among all consecutive patients admitted with MI was 10.3%. The risk factors for MINOCA and the significant distinctions between these and the conventional risk factors for coronary artery disease were elucidated. The clinical outcomes for patients in both groups were comparable, including in-hospital and remote mortality rates. The incidence of rehospitalization for cardiac causes was higher in the MINOCA group.

No conflict of interest is reported.

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Prevalence, Clinical Features, Treatment, and Outcomes in Patients With Myocardial Infarction With Non-Obstructive Coronary Arteries

SUPPLEMENTARY MATERIALS

Annex 1. . Identification of the triggers that cause an imbalance between myocardial oxygen demand and delivery

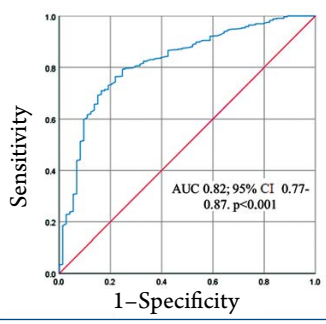
Clinical conditions that result in decreased oxygen delivery:
– Anemia defined as a hemoglobin concentration of less than 100 g/L or a decrease in hemoglobin of more than 20 g/L within a 48-hour period, and/or the need for a hemotransfusion;
– Bradyarrhythmia that requires medical intervention or cardiac stimulation.
Conditions that result in an increased myocardial demand for oxygen:
– Ventricular tachycardia lasting 20 minutes;
– Supraventricular tachycardia with a ventricular contraction rate exceeding 120 beats per minute, with the exception of sinus tachycardia;
– Hypertensive crisis/pulmonary edema defined as elevated systolic blood pressure above 160 mm Hg that necessitates treatment with nitrates or diuretics, and/or the presence of concomitant left ventricular hypertrophy, as determined by echocardiography or electrocardiography;
– Bronchopulmonary infection diagnosed through a combination of clinical examinations and laboratory tests, with further verification by chest radiography and/or computed tomography.

Annex 2. Factors associated with myocardial infarction with non-obstructive coronary arteries

Parameters	OR, 95 % CI in univariate analysis	p	OR, 95 % CI in multivariate analysis	p
Age ≤ 58 years	1.03 (1.01–1.06)	0.001	1.04 (1.0–1.07)	0.032
Female	1.70 (1.04–2.76)	0.033	2.29 (1.25–4.21)	0.008
No ST-segment elevation in ECG	6.73 (3.39–13.35)	< 0.001	4.72 (2.22–10.04)	< 0.001
Charlson Comorbidity Index ≤ 3	1.25 (1.09–1.43)	0.001	1.26 (0.99–1.61)	0.062
Absence of chest pain	3.98 (2.07–7.65)	< 0.001	2.01 (0.81–4.98)	0.130
Dyspnea	1.94 (1.11–3.38)	0.019	1.84 (0.88–3.84)	0.103
Syncope	3.84 (1.31–11.23)	0.014	2.38 (0.58–9.47)	0.228
LBBB	2.59 (1.27–5.29)	0.009	2.29 (0.96–5.45)	0.061
Absence of hypo/akinesia zones	4.05 (2.42–6.79)	< 0.001	3.1 (1.48–6.48)	0.003
Aortic stenosis	2.59 (1.14–5.90)	0.024	2.97 (1.07–8.24)	0.036
Hypertensive crisis/pulmonary edema	1.79 (1.07–2.98)	0.026	1.45 (0.80–2.63)	0.222
Bronchopulmonary infection	2.50 (1.10–5.68)	0.029	3.74 (1.21–11.53)	0.022
LVEF ≥ 48 %	0.94 (0.91–0.97)	< 0.001	1.00 (0.97–1.05)	0.697

LBBB, left bundle branch block; CI, confidence interval; OR, odds ratio, LVEF, left ventricular ejection fraction; HR, heart rate.

Annex 3. ROC curve of factors associated with the presence of MI with non-obstructive coronary arteries



AUC, area under the ROC Curve;
CI, confidence interval.