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Determinants of Adverse Outcomes after Myocardial Infarction in Young Patients: A Clinico-Metabolic and Structural Analysis

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Abstract Background. Myocardial infarction (MI) in young individuals is an increasingly recognized clinical problem associated with distinct risk factors and prognostic features. Aim. To evaluate clinical, metabolic, and structural-functional characteristics of MI in young patients and to identify predictors of adverse cardiovascular outcomes. Material and methods. A prospective cohort study included 108 young patients (18–45 years) with confirmed MI and 35 older patients (60–75 years). Clinical, laboratory, echocardiographic, and angiographic parameters were assessed at baseline and during a 12-month follow-up. The primary endpoint was a composite of major adverse cardiovascular events (MACE), including cardiovascular death, recurrent MI, unstable angina, and revascularization. Receiver operating characteristic (ROC) analysis and Kaplan–Meier survival analysis were performed. Results. Young patients were predominantly male (85.2%) and more frequently presented with ST-elevation MI (84.3%). Smoking was significantly more prevalent among young patients compared to older individuals (70.2% vs 20.6%, p<0.001), along with a higher prevalence of family history of early coronary artery disease. In contrast, hypertension and type 2 diabetes were more common in older patients. Coronary angiography demonstrated a higher prevalence of single-vessel disease in young patients (48.9% vs 26.7%, p=0.033), whereas multivessel disease predominated in the elderly group. At 12 months, MACE occurred in 24% of young patients, with a mortality rate of 3%. ROC analysis showed good predictive performance of selected parameters (AUC >0.70), while Kaplan–Meier analysis revealed significantly lower event-free survival in high-risk patients. Smoking, hypertension, and increased platelet aggregation were identified as independent predictors of adverse outcomes. Conclusion. Young MI patients exhibit a distinct clinical profile characterized by a high prevalence of modifiable risk factors and predominantly single-vessel coronary disease. Despite relatively favorable baseline characteristics, they remain at substantial risk of adverse cardiovascular outcomes. Aggressive risk factor modification and personalized long-term management strategies are essential to improve prognosis.

Keywords: *Myocardial infarction, young patients, prognosis, risk factors, ROC curve, Kaplan–Meier, cardiovascular outcomes*

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1. Introduction

Ischemic heart disease remains the leading cause of mortality worldwide [1,3]. Myocardial infarction (MI) in young individuals (≤45 years) accounts for up to 10% of all cases and represents a growing clinical concern [5,6].

Unlike older patients, MI in young individuals is often the first manifestation of coronary artery disease and is associated with a distinct risk factor profile [4,5]. Modifiable factors such as smoking and dyslipidemia play a central role, while traditional comorbidities are less prevalent [4].

Despite relatively preserved cardiac function, young patients remain at significant risk of recurrent cardiovascular events [7]. Identification of prognostic factors and development of personalized treatment strategies are essential.

2. Methods

This prospective observational cohort study included 143 patients with confirmed myocardial infarction [2,8], comprising 108 young patients (18–45 years) and 35 older

patients (60–75 years) .

Inclusion criteria were age ≥18 years, confirmed MI diagnosis, and informed consent [8]. Exclusion criteria included severe comorbid conditions, atrial fibrillation, significant valvular disease, advanced liver or kidney disease, and psychiatric disorders .

All patients underwent clinical assessment, laboratory testing (lipid profile, glucose, renal function), hemostasis evaluation, electrocardiography, echocardiography, and coronary angiography.

Patients were followed for 12 months. The primary endpoint was a composite of major adverse cardiovascular events (MACE), including cardiovascular death, recurrent MI, unstable angina and revascularization [2].

Statistical analysis was performed using SPSS v23. Continuous variables were expressed as mean ± SD or median (IQR), and categorical variables as percentages. Group comparisons were performed using t-test, Mann–Whitney U test, and χ^2 test.

ROC curve analysis was used to assess predictive performance, and Kaplan–Meier analysis was applied to evaluate event-free survival. A p-value <0.05 was considered statistically significant.

3. Results

A total of 143 patients were included in the study, comprising 108 young patients (aged 18–45 years) and 35 older patients (aged 60–75 years).

Young patients were predominantly male (85.2% vs 37.1%, p<0.001) and more frequently presented with ST-elevation myocardial infarction (STEMI) (84.3% vs 48.5%, p<0.001). Smoking was significantly more prevalent among young individuals (70.2% vs 20.6%, p<0.001), as well as a positive family history of early coronary artery disease (54.6% vs 16.0%, p=0.001).

In contrast, older patients had a higher prevalence of hypertension (88.2% vs 58.8%, p=0.002) and type 2 diabetes mellitus (29.4% vs 7.4%, p<0.001).

These findings indicate a distinct risk factor profile, with modifiable behavioral factors predominating in young patients, while comorbid conditions are more common in older individuals.

Table 1. Baseline Clinical Characteristics

Variable	Young (n=108)	Older (n=35)	p-value
Male sex (%)	85.2	37.1	<0.001
STEMI (%)	84.3	48.5	<0.001
Smoking (%)	70.2	20.6	<0.001
Family history (%)	54.6	16.0	0.001
Hypertension (%)	58.8	88.2	0.002
Type 2 diabetes (%)	7.4	29.4	<0.001

Coronary angiography revealed significant differences in the extent of coronary artery disease between the groups.

Single-vessel disease was more frequently observed in young patients (48.9% vs 26.7%, p=0.033), whereas multivessel disease was significantly more common in older individuals (56.7% vs 30.9%, p=0.011). The number of affected coronary segments was also lower in the young group (median 2.0 vs 3.5, p=0.004).

Echocardiographic assessment demonstrated that young patients had significantly higher left ventricular end-diastolic volume (EDV) compared to older patients (p=0.013).

Table 2. Coronary Angiographic Characteristics

Variable	Young (%)	Older (%)	p-value
Single-vessel disease	48.9	26.7	0.033
≥3-vessel disease	30.9	56.7	0.011
Number of segments (median)	2.0	3.5	0.004

Although left ventricular ejection fraction (LVEF) was relatively preserved in both groups, a tendency toward lower LVEF and higher rates of systolic dysfunction was observed in older patients.

Among young patients, those with recurrent myocardial infarction exhibited significantly worse cardiac function, including increased left ventricular volumes and reduced ejection fraction.

Table 3. Echocardiographic Parameters

Parameter	Young	Older	p-value
EDV (mL)	114.5	94.5	0.013
LVEF (%)	50.5	47.9	0.191
Systolic dysfunction (%)	44.1	60.0	0.129

During the 12-month follow-up period, major adverse cardiovascular events (MACE) occurred in 24% of young patients. Cardiovascular mortality was 3%, recurrent myocardial infarction occurred in 4%, and unstable angina in 7% of cases.

No statistically significant difference in the composite endpoint was observed between young and older patients; however, the burden of adverse outcomes in young individuals remained clinically significant.

Table 4. Clinical Outcomes in Young Patients

Outcome	Percentage (%)
Cardiovascular death	3.0
Recurrent MI	4.0
Unstable angina	7.0
MACE	24.0

Receiver operating characteristic (ROC) analysis was performed to evaluate the predictive value of selected risk factors for adverse cardiovascular outcomes.

Platelet aggregation demonstrated the highest predictive performance (AUC = 0.75), followed by smoking (AUC = 0.72) and hypertension (AUC = 0.69).

These findings indicate that platelet aggregation may serve as a useful biomarker for risk stratification in young MI patients.

Table 5. ROC Analysis of Predictors of MACE

Variable	AUC	Sensitivity	Specificity
Platelet aggregation	0.75	73%	70%
Smoking	0.72	70%	68%
Hypertension	0.69	65%	66%

The ROC curve analysis demonstrated good discriminative performance of the evaluated parameters for predicting MACE. Platelet aggregation showed the highest prognostic value, with an area under the curve (AUC) of 0.75, indicating moderate-to-good predictive accuracy. These findings suggest that platelet aggregation may serve as a clinically relevant marker for risk stratification in patients with myocardial infarction.

Kaplan–Meier survival analysis revealed a significantly lower event-free survival rate among patients with multiple risk factors. Patients with two or more risk factors demonstrated a markedly higher incidence of adverse cardiovascular events compared to those with fewer risk factors (log-rank test, $p < 0.01$).

At 12 months, event-free survival was approximately 88–90% in the low-risk group and 70–75% in the high-risk group, indicating a substantial impact of cumulative risk burden on clinical outcomes.

The Kaplan–Meier survival curve demonstrates a clear separation between low-risk and high-risk groups over the 12-month follow-up period. This separation confirms the prognostic significance of combined risk factor assessment and highlights the importance of integrated risk stratification in young patients with myocardial infarction.

4. Discussion

The present study provides a comprehensive evaluation of clinical, metabolic, and structural-functional characteristics of myocardial infarction (MI) in young patients and highlights important differences compared to older individuals.

A key finding of this study is the distinct risk factor profile observed in young patients. Smoking emerged as the predominant risk factor, with a significantly higher prevalence compared to older patients. In addition, a positive family history of early coronary artery disease was more frequently observed, suggesting a potential contribution of genetic predisposition. In contrast, traditional comorbidities such as hypertension and type 2 diabetes mellitus were more prevalent in older patients. These findings are consistent with previous studies indicating that MI in young individuals is largely driven by modifiable behavioral and hereditary factors rather than long-standing metabolic disease.

Another important observation relates to coronary angiographic characteristics. Young patients were more likely to present with single-vessel disease, whereas multivessel involvement predominated in older individuals. This suggests that the underlying pathophysiological mechanisms may differ between age groups, with localized plaque instability playing a more prominent role in younger patients, as opposed to diffuse atherosclerosis in the elderly.

Echocardiographic assessment revealed relatively preserved left ventricular systolic function in young patients; however, those with recurrent MI demonstrated significantly worse cardiac remodeling, including increased ventricular volumes and reduced ejection fraction. These findings underscore the clinical importance of secondary prevention in this population, as recurrent events are associated with substantial deterioration in cardiac function.

Despite a more favorable baseline profile, the incidence of major adverse cardiovascular events (MACE) in young patients remained considerable, reaching 24% at 12 months. This highlights that young age does not confer protection against adverse outcomes following MI. The persistence of modifiable risk factors, particularly smoking and suboptimal adherence to therapy, likely contributes to this observation.

The prognostic analysis further demonstrated that smoking, hypertension, and increased platelet aggregation were significantly associated with adverse outcomes. Notably, platelet aggregation showed the highest predictive performance in ROC analysis, suggesting its potential role as a useful biomarker for risk stratification.

Kaplan–Meier survival analysis confirmed the prognostic significance of cumulative risk burden, demonstrating significantly lower event-free survival in patients with multiple risk factors. These findings emphasize the importance of comprehensive risk assessment and individualized management strategies in young MI patients.

From a clinical perspective, the results of this study highlight the need for aggressive modification of risk factors, particularly smoking cessation, as well as improved long-term adherence to guideline-directed medical therapy. Early identification of high-risk individuals may allow for more intensive monitoring and tailored therapeutic interventions.

5. Conclusion

Myocardial infarction in young patients is characterized by a distinct clinical profile, including a high prevalence of modifiable risk factors, particularly smoking, and a predominance of single-vessel coronary artery disease.

Despite relatively preserved cardiac function at baseline, young patients remain at substantial risk of adverse cardiovascular outcomes, with a 12-month MACE rate of 24%. Smoking, hypertension, and increased platelet aggregation were identified as key predictors of poor prognosis.

ROC and Kaplan–Meier analyses confirmed the importance of risk stratification, demonstrating that patients with multiple risk factors have significantly lower event-free survival.

These findings underscore the critical importance of early risk factor modification, personalized treatment strategies, and long-term follow-up in improving outcomes among young patients with myocardial infarction [1,9,10].

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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