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Comparison of factors associated with ST-segment elevation myocardial infarction (STEMI) complications in young versus older adults: A post hoc analysis of a single-centre registry

Comparaison des facteurs associés aux complications de l'infarctus du myocarde avec sus-décalage du segment ST (STEMI) chez les jeunes adultes par rapport aux adultes plus âgés : Analyse post hoc d'un registre monocentrique

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Résumé

Contexte & objectif. L'influence de l'âge sur le syndrome coronarien aigu avec sus-décalage persistant du segment ST (SCA ST (+)) est débattable. La présente étude visait à comparer les complications aiguës entre les patients jeunes (≤ 55 ans) et plus âgés (> 55 ans), et à en identifier les déterminants.

Méthodes. Dans une analyse post hoc, les données des patients hospitalisés pour SCA ST (+) ont été analysées, avec recours à la méthode régression logistique multivariée. *Résultats*. Trois cent quinze dossiers des patients ont été colligés. Le tabagisme était le principal facteur de risque cardiovasculaire (FRCV) chez les jeunes, l'hypertension artérielle chez les plus âgés. Les complications les plus fréquentes étaient les arythmies et l'insuffisance cardiaque aiguë (ICA), cette dernière touchant davantage les patients âgés. Chez les jeunes, les arythmies étaient associées à l'artériopathie oblitérante des membres inférieurs, à un coefficient d'athérogénicité et à un index d'athérogénicité plasmatique élevés. Chez les plus âgés, elles l'étaient au diabète, à une cardiopathie ischémique préexistante et à un indice de Castelli I élevé. Le tabagisme, une CRP ultrasensible et un coefficient d'athérogénicité élevés majoraient le risque d'ICA dans les deux groupes. L'indice d'athérogénicité plasmatique élevé n'était significatif que chez les jeunes. *Conclusion*. Cette étude Souligne

Summary

Context and objective. The impact of age on coronary artery disease prognosis is debated. This study compared acute complications in younger (≤55 years) and older (>55 years) ST-segment elevation myocardial infarction (STEMI) patients. *Methods.* A post hoc analysis of demographics, cardiovascular risk factors (CVRF), clinical, echocardiographic, and coronary angiography data for STEMI patients was carried out. Multivariate logistic regression analysis identified factors associated with complications in each group. *Results.* Three hundred fifteen data of STEMI patients were analyzed. Smoking and hypertension were the main CVRF in younger and older patients, respectively. Arrhythmias and acute heart failure (AHF) were the most common complications, with AHF more prevalent in the elderly. In younger, arrhythmias risk was associated with peripheral arterial disease (aOR, 3.84), high atherogenic coefficient (aOR, 2.49), and atherogenic index of plasma (aOR, 2.42). In older patients, it was associated with diabetes mellitus (aOR, 3.05), ischemic heart disease (aOR, 1.79), and Castelli Risk Index I (aOR, 2.07). Smoking, elevated hs-CRP, and atherogenic coefficient increased AHF risk in both groups, while atherogenic index of plasma (aOR, 4.34) increased it only in younger patients. *Conclusion.* The present study reveals distinct CVRF profiles and complications in younger versus older STEMI patients. Some AHF risk factors overlap, while arrhythmia

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l'importance d'une approche thérapeutique du SCA ST5 (+) adaptée à l'âge.
Mots-clés : syndrome coronarien aigu avec sus-décalage persistant du segment ST [(SCA ST (+)], Patients âgés, jeunes patients, complications, coronarographie
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determinants vary, suggesting age-specific treatment protocols.
Keywords: ST Segment Elevation Myocardial Infarction (STEMI), Elderly Patients, Young Patients, complications, Coronary Angiography

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Introduction

Acute coronary syndrome (ACS) encompasses a spectrum of conditions associated with sudden, reduced blood flow to the heart, with ST segment elevation myocardial infarction (STEMI) representing one of the most critical manifestations (1). The presentation, management, and outcomes of STEMI can vary significantly based on patient demographics, particularly age (2). As populations age globally, understanding the distinct characteristics and outcome of elderly patients compared to their younger counterparts becomes a very important issue. Many studies have examined the specific characteristics of ACS by age group, focusing mainly on the epidemiological profile, associated cardiovascular risk factors, comorbidities, pathophysiology, clinical presentation and mortality in both STEMI and non-STEMI patients. However, to our knowledge, no study has specifically analyzed the factors associated with these complications by age group in the particular context of STEMI.

Elderly patients with STEMI often have multiple comorbidities and cardiovascular risk factors, such as hypertension, diabetes, and renal impairment, which can complicate diagnosis and treatment. These patients face higher risks of poor outcomes, are less likely to receive guideline-recommended therapies, and have higher mortality rates (3). In contrast, younger patients typically have a different risk profile, with more lifestyle-related factors like smoking, but fewer chronic health issues (4).

Although STEMI mortality decreased with the progress of reperfusion therapy, acute complications remain unchanged. A study by Bono *et al*. identified preadmission cardiac arrest, left ventricular ejection fraction < 40%, and age > 68 as predictors of complications in STEMI patients (5). Mavungu et al. found that acute heart failure and arrhythmias were common complications, with age ≥ 75, hypertension, diabetes, smoking, a history of atrial fibrillation or stroke, and low HDL-C levels being the determinants of these complications (6). However, neither Bono, Mavungu, nor anyone else have examined whether these risk factors apply similarly to older and younger patients.

Assuming that complications and associated factors vary according to the age of patients, this study aimed to provide a detailed comparative analysis of the demographics, medical history, presentation and acute complications of elderly and young STEMI patients. By elucidating these differences, we seek to contribute valuable insights into the management of STEMI across age groups.

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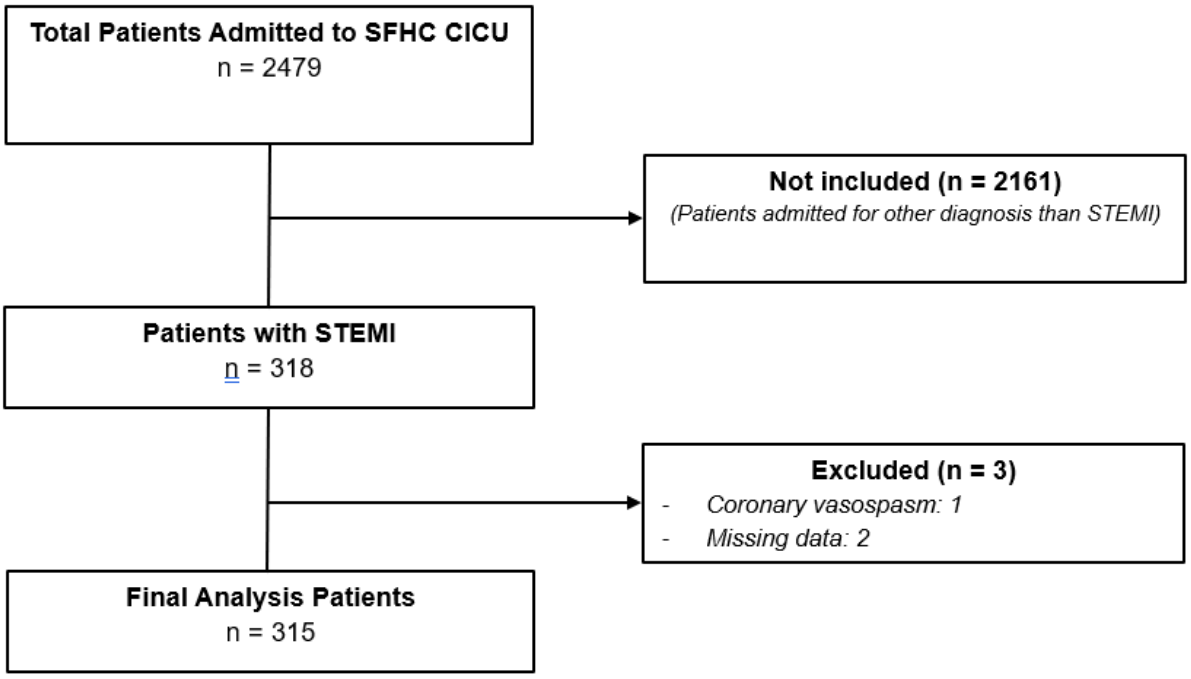
Methods

This post-hoc analysis examined the records of patients with STEMI admitted to the Cardiology Intensive Care Unit (CICU) at the Sud Francilien Hospital Center (SFHC) in the French Republic from January 1, 2020 to December 31, 2021.

The detail of study design and protocol have been previously described elsewhere (6). In summary, two researchers reviewed medical records of patients admitted for STEMI to extract relevant data. The information collected included sociodemographic data (age, sex, occupation), cardiovascular risk factors **(**hypertension, diabetes, dyslipidemia, smoking, obesity, family history of coronary disease), medical history **(**prior ischemic heart disease, limb arterial disease, previous interventions such as carotid angioplasty, heart rhythm disorders, stroke/TIA, heart failure, chronic renal failure, cancer, pulmonary embolism, COVID-19), clinical data (blood pressure, heart rate, oxygen saturation), electrocardiographic data **(**bundle branch block, rhythm, conduction disorders), echocardiographic data **(**left ventricular ejection fraction, kinetic disorders), biological data **(**serum creatinine, renal function assessed via creatinine clearance), glycated hemoglobin (HbA1c), cholesterol levels, triglycerides), coronary angiographic findings (type and number of occluded coronary arteries, number of stents implanted), and complications (rhythm and conduction disorders, heart failure, mechanical and embolic complications such as ischemic stroke).

All patients underwent primary percutaneous coronary intervention and were monitored for vital signs and lead electrocardiogram (ECG) within 24 hours of admission in the intensive cardiac care units using a portable monitor. Follow-up included monitoring symptoms such as dyspnea, chest pain, and palpitations, as well as additional biological tests. Complications from initial EMS contact to 24 hours post-CICU admission were recorded. Patients received treatment according to ESC guidelines for STEMI.

Of the 2479 patients admitted to the SFHC CICU during the study period, 1279 had coronary disease, with 318 having SCA-ST+. Three patients were excluded because one had a coronary vasospasm, and two had missing data in their medical files. A total of 315 patients were selected for the final analysis. Figure 1 summarizes the selection procedure.



SFHC CICU = Sud Francilien Hospital Center Cardiology Intensive Care Unit

Figure 1. Flow chart of study population

Operational definitions

The following definitions were used in this study:

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Young patients were defined as being 55 years of age or younger, while older individuals were defined as being over 55 years of age (7).
The diagnosis of STEMI and its complications were made by qualified cardiologists based on their personal clinical judgment and the current guidelines.
STEMI was defined as per the 2017 recommendations of the ESC (8). High Low-density Lipoprotein Cholesterol (LDL-C)was defined as LDL-C level ≥ 1.6 g/L, low high-density lipoprotein cholesterol (HDL-C) 1 was defined as HDL-C level ≤ 0.40 g/L in men and ≤ 0.50 g/L in women, high total-cholesterol (TC) was defined as TC level ≥ 2 g/L, high triglyceride was defined as triglyceride level ≥ 1.5 g/L (8), high atherogenic index of plasma (AIP) was defined as AIP level above the 75th percentile, high Castelli Risk Index I (CRI-I) was defined as CRI-I level above the 75th percentile, high Castelli Risk Index II (CRI-II) as defined as CRI-II level above the 75th percentile, high atherogenic coefficient (AC) was defined as AC level above the 75th percentile, high non-HDL-C (NHC) was defined as NHC level above the 75th percentile. The various atherogenic indices were calculated using the following established formulas (9-11): AIP = Log TG/ HDL-C, CRI-I=TC/HDL-C, CRI-II=LDL/HDL-C, AC= TC–HDL-C /HDL-C, and NHC=TC-HDL-C. High blood high-sensitivity C-reactive protein (hs-CRP) was defined as > 6 mg/dl.
Left ventricular ejection fraction (LVEF) values were categorized into three groups according to the 2021 ESC recommendations (12), as follows: “reduced” when the LVEF was ≤ 40%; “mildly reduced” when the LVEF was between 40% and 49%; and “preserved” when the LVEF was ≥ 50%.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (version 24; IBM Corp., Armonk, NY, USA). Patients were categorized into two subgroups according to age: age ≤ 55 years versus > 55 years. Continuous and categorical variables are expressed as means±standard deviations and relative frequency in percent, respectively. Comparisons of means and proportions were performed using Student’s t-test and the chi-square test, respectively. Simple logistic regression was used to determine which factors were predictive of complications, including elderly and younger adults separately in the model. The following variables were entered into the univariate analysis: CVRFs (hypertension, diabetes mellitus, high LDL-C, low HDL-C, high TC, high triglyceride, high AIP, high CRI-I, high CRI-II, high AC, high NHC, obesity, cigarette smoking, and coronary heredity), medical history (stented ischemic heart disease, coronary artery bypass surgery, previous atrial fibrillation, previous stroke, heart failure, chronic kidney disease, peripheral artery occlusive disease (PAD), neoplasia, pulmonary embolism, and COVID-19), the number of occluded vessels (monovessel, bivessel, and trivessel), and LVEF (reduced, moderately reduced, preserved). The odds ratios (ORs) and their 95% confidence intervals (95% CIs) were finally calculated to assess the degree of association between the variables and occurrence of complications. When the associations were observed between complications and these independent variables, the effects of potential confounders were examined by adjustment in a conditional logistic regression (multivariate analysis). P-values < 0.05 were used to denote statistical significance.

Ethics approval

All experiments were performed in accordance with relevant guideline and regulations of Declaration of Helsinki. Data was fully anonymized before being accessed and the source of data was made from patient records.
This study was reviewed and approved by the SFHC Ethics Committee, and all the included patients signed written informed consent.

Results

Characteristics of the study population

The study population consisted of 315 patients with a mean age of 61.7 ± 13.4 years. Of these patients, 104 (33.0%) patients were aged 55 years and under, while 211 (67%) patients were over 55 years old. 261(82.9%) were male and 54 (17.1%) were female, resulting in a sex ratio of 4.8.

Cardiovascular risk factors, history and comorbidities according to age

Table 1 shows that smoking was the primary modifiable cardiovascular risk factor, followed by systemic vascular inflammation, hypertension and high NHC, with 184 (58.8%), 158 (50.5%), 135 (42.9%) and 101 (32.1%) patients respectively. Additionally, the table indicates that smoking was significantly more prevalent among young patients, while high blood pressure was significantly more common among elderly patients. Coronary inheritance, as a non-modifiable cardiovascular risk factor, was reported in 32 (20.3%) patients and was found in

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similar proportions among young and elderly patients. Ischemic heart disease was the most common history among the patients studied.
Different histories and comorbidities were present at similar proportions in young and old patients, with the exception of neoplasia, acute lung edema and renal failure which were significantly more common in elderly patients.

Table 1. Distribution of cardiovascular risk factors, history and comorbidities according to age

Variable	≤55 years old (n=104)	>55 years old (n=211)	P
Hypertension	33 (31.7)	102 (48.3)	**0.003**
Diabetes	20 (19.2)	42 (19.9)	0.508
Obesity	21 (20.2)	40 (19.0)	0.452
Coronary inheritance	14 (23.7)	18 (18.2)	0.261
Smoking	79 (76.0)	105 (50.2)	**<0.001**
High TC	25 (24.0)	55 (26.1)	0.404
Low HDL-C	1 (1.0)	1 (0.9)	0.729
High LDL-C	45 (46.4)	30 (28.3)	0.028
Hypertriglyceridemia	30 (30.9)	39 (36.8)	0.232
High AIP	36 (34.6)	39 (19.0)	0.002
High CRI I	27 (27.0)	49 (24.3)	0.351
High CRI II	27 (26.0)	50 (24.4)	0.433
High AC	38 (38.0)	37 (18.3)	<0.001
high NHC	**45 (47.4)**	**56 (52.8)**	**0.264**
high hsCRP	52(50.0)	106 (50.7)	0.500
ischaemic heart disease	15(14.4)	33 (15.7)	0.452
Atrial fibrillation	0	11 (5.2)	-
Stroke or TIA	1 (1.0)	6 (2.8)	0.266
CKD	0	8 (3.8)	-
PAD	2 (1.9)	4 (1.9)	0.645
Neoplasia	3 (2.9)	19 (9.0)	0.033
RCA	4 (3.8)	8 (3.8)	0.601

TC = total cholesterol, HDL-C = high density lipoprotein, LDL-C = low density lipoprotein, AIP = atherogenic index of plasma, CRI I = Castelli Risk Index I, CRI II = Castelli Risk Index II ; AC, atherogenic coefficient; NHC, non-HDL-C, hsCRP = high-sensitivity C-reactive protein; TIA = A transient ischemic attack, CHD = chronic kidney disease, PAD = peripheral artery disease, RCA = recovered cardiac arrest

Clinical, biological, coronary angiography characteristics, and LVEF of the study population

Table 2 presents the clinical, biological, coronary angiography characteristics and LVEF of the study population. The table indicates that the average values of systolic blood pressure, diastolic blood pressure, heart rate, oxygen saturation and temperature were all within normal limits for the patients studied. These values were found to be statistically similar between older and younger patients.
Additionally, the table reveals that elderly patients had significantly lower values of glomerular filtration rate, HDL-C, triglycerides, atherogenic index of plasma (AIP) and atherogenic coefficient. Conversly, they had significantly higher values Castelli Risk Index I (CRI-I), and NT-proBNP.
Moreover, the table shows that 198 (62.8) patients had a preserved LVEF, while 76 (24.1%) patients had a moderately reduced LVEF fraction and 41 (13.0%) patients had a reduced LVEF. The same table depicts those 186 (49.5%) patients had a monovessel lesion, 86 (44.2%) had a bivessel lesion and 43 (6.3%) had a trivessel lesion. The left anterior descending artery (LADA) was the most common of the monovessel lesion, affected in 92 (49.5%) patients. The duo of LADA and RCA was the most common of the bivessel lesion,

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affected in 21 (24,42%) patients. The trio LADA, LCA, and RC, was the most common trivessel lesion, affected in 25 (58.13%) patients. The frequency of these lesions was similar in both age groups.

Table 2. Clinical, biological, coronary angiography characteristics, and LVEF of patients according to age

Variables	≤ 55 years old n =104	> 55 years old n=211	P
Clinical variables			
SBP (mmHg)	122.4 ± 21.8	121.9 ± 22.4	0.462
DBP (mmHg)	74.8 ± 13.2	64.4 ± 10.8	0.017
Heart rate (bpm)	77.2 ± 14.8	77.8 ± 14.5	0.190
Oxygen saturation (%)	97.7 ± 2.0	97.7 ± 2.1	0.092
Creatinine (µmol/l)	86.1 ± 27.8	86.8 ± 29.8	0.495
GFR (ml/min/1.73m2)	97.9 ± 22.7	88.0 ± 29.2	**0.003**
HbA1c (%)	6.1 ± 1.5	6.1 ± 1.2	0.818
Hs-CRP (mg/dl)	5.8 (4.0-8.0)	6.1 (5.0-7.0)	0.556
TC (mg/dl)	1.83 ± 0.46	1.77 ± 0.48	0.238
LDL-C (mg/dl)	1.26 ± 0.42	1.17 ± 0.41	0.079
HDL-c (mg/dl)	0.41 ± 0.19	0.47 ± 0.19	**0.016**
Triglycerides (mg/dl)	1.33 (1.13-1.50)	1.14 (1.04-1.21)	**<0.001**
AIP	0.55 (0.47-0.62)	0.43 (0.39-0.48)	**<0.001**
CRI-I	3.09 (1.59-3.42)	3.31 (3.0-3.45)	**0.037**
CRI-II	1.84 (1.29-2.09)	2.04 (1.81-2.30)	0.471
AC	3.67 (3.36-4.10)	3.01 (2.73-3.20)	**<0.001**
NHC	3.4 (3.2–3.9)	3.2 (2.8–3.5)	0.136
NT-proBNP (pg/mL)	457.5 (359.5-598.0)	897.0 (663.5-1183.0)	**0.005**
Troponine at admission (pg/ml)	345.0 (125.0-500.0)	345.0 (241.0-500.0)	0.309
Troponin at the peak (pg/ml)	2500 (1584-2886)	2800 (2250-3304)	0.770
CPK at admission (pg/ml)	258.0 (231.0-351.5)	236.0 (196-265.9)	0.313
CPK at the pick (pg/ml)	659 (600-1017)	780.0 (675-899.5)	0.984
LVEF (%)	50.90 ± 11.69	50.55 ± 10.77	0.244
≥50	30 (28.9)	168 (79.6)	
40-49	18 (17.3)	58 (27.5)	
<40	6 (5.8)	35 (16.6)	
Monovessel			0.512
LADA	12 (11.5)	80 (38.0)	
RC	11 (10.6)	43 (20.4)	
LCA	3 (2.9)	19 (10.22)	
Others	2 (1.9)	16 (7.5)	
Bivessel			0.851
LCA and RCA	0	5 (2.4)	
LADA and RCA	8 (7.7)	30 (14.2)	
LADA and LCA	6 (5.8)	15 (7.1)	

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Others	2 (1.9)	20 (9.5)	
Trivessel			0.407
LADA, OM, and RCA	0(0.0)	3 (1.42)	
LADA, LCA, and RCA	6 (5.8)	19 (9.0)	
Others	5 (4.8)	10 (4.7)	

SBP = systolic blood pressure, DBP = diastolic blood pressure, GFR = glomerula filtration rate, HbA1c = glycated hemoglobin, hs-CRP = high-sensitivity C-reactive protein, TC = total cholesterol, HDL-c = high density lipoprotein, LDL-c = low density lipoprotein, AIP = atherogenic index of plasma, CRI-I = Castelli Risk Index I, CRI-II = Castelli Risk Index II, AC = atherogenic coefficient, NHC = non-HDL-C, NT-proBNP = N-terminal pro b-type natriuretic peptide, CPK = Creatine phosphokinase, LVEF = left ventricular ejection fraction, LADA = left anterior descending artery, RI = ramus intermedius, RC = right coronary, LCA = left coronary artery, D = diagonal, PDA = posterior descending artery, OM = obtuse marginal, PLA = posterolateral artery, RCA = right coronary artery

Post-STEMI Acute complications

Table 3 shows that the main complications were heart rhythm disorders and AHF. These complications were found in 68 (21.6%) and 45 (12.3%) patients respectively. AHF was significantly more common in elderly patients while the frequency of cardiac rhythm disorders was similar in both age groups. The same table shows that atrial fibrillation and unsustained ventricular tachycardia, present in 27 (8.6%) patients respectively, were the main cardiac rhythm disorders found in the studied patients. Atrial fibrillation was significantly more common in elderly patients than in younger patients.

Tableau 3. Distribution of complications according to age

Variable	≤55 years old n=104	>55 years old n=211	P
Acute heart failure	3(2.9)	42(19.9)	<0.001
KILLIP ≥ II			0.001
II	2(1.9)	23(10.9)	
III	0	10(4.7)	
IV	1(1.0)	9(4.3)	
Arrhythmias	22(21.2)	46(21.8)	0.509
Atriale fibrillation	3(2.9)	24(11.4)	0.007
NSVT	12(11.5)	15(7.1)	0.135
SVT	6(5.8)	6(2.8)	0.167
Others	1 (1.0)	5 (2.3)	-
Conduction disorders			
AV block	4(3.8)	6(2.8)	0.432
BAV 1	2(1.9)	2(0.9)	
Mobitz I AV block	1(1.0)	0(0.0)	
Mobitz II AV block	1(1.0)	1(0.5)	
Third-degree AV block	0(0.0)	3(1.4)	
Other complications	5(4.8)	10(4.7)	0.670
Puncture site hematoma	1(1.0)	5(2.4)	0.335
Ischemic stroke	3(2.9)	2(0.9)	0.204
Others	1(1.0)	3(1.5)	-

NSVT = Nonsustained ventricular tachycardia, SVT = Sustained ventricular tachycardia, AV block = Atrioventricular block

Factors associated with post-STEMI acute complications

Table 4 shows that peripheral arterial disease, recovered cardiac arrest, and atherogenic index of plasma were associated with cardiac arrhythmias in young patients, both in bivariate and multivariate analysis. In elderly patients, factors associated with the occurrence of cardiac

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arrhythmias were diabetes mellitus, ischemic heart disease, peripheral arterial disease, and a high Castelli Risk Index II. After adjusting for confounding factors, diabetes mellitus increased the risk of cardiac arrhythmias by 3, ischemic heart disease by 2, and a high Castelli Risk Index II by 2.

Table 4. Bi- and multivariate analysis of factors associated with the occurrence of cardiac rhythm disorders

Variable	Age ≤ 55 years		Age > 55 years	
	bivariate analysis			
	p	OR (IC95 %)	P	OR (IC95 %)
Diabetes				
No		1		1
Yes	0.888	0.92 (0.27-3.08)	**0.005**	2.85 (1.36-5.96)
Ischemic heart disease				
No		1		1
Yes	0.573	1.43 (0.41-2.04)	**0.018**	2.92 (1.90-4.57)
PAD				
No		1		1
Yes	**0.034**	3.86 (2.23-4.63)	**0.001**	3.71 (1.57-4.78)
AC				
No		1		1
Yes	**0.031**	2.79 (1.26-3.79)	0.524	0.50 (0.06-2.84)
High AIP				
No		1		1
Yes	**0.012**	2.28 (1.87-5.95)	0.872	0.93 (0.94-2.20)
High CRI I				
No		1		1
Yes	0.360	0.57 (0.17-1.89)	**0.018**	1.89 (1.09-3.91)
	multivariate analysis			
	p	ORa (IC95 %)	p	ORa (IC95 %)
Diabetes				
No		1		1
Yes	0.984	0.99 (0.26-3.74)	**0.008**	3.05 (1.34-6.94)
ischemic heart disease				
No		1		1
Yes	0.613	1.46 (0.34-2.35)	**0.022**	1.79 (1.13-4.49)
PAD				
No		1		1
Yes	**0.025**	2.84 (1.11-3.71)	0.346	1.23 (0.32-2.47)
AC				
No		1		1
Yes	**0.045**	2.49 (1.53-3.85)	0.963	1.03 (0.21-1.14)
High AIP				
No		1		1
Yes	**0.024**	2.42 (1.49-4.15)	0.189	1.13 (0.19-1.39)
High CRI I				
No		1		1
Yes	0.579	1.17 (0.20-2.46)	**0.026**	2.07 (1.63-4.43)

PAD = peripheral artery disease, AC = atherogenic coefficient, AIP = atherogenic index of plasma, CRI I = Castelli Risk Index I

Table 5 illustrates the factors associated with AHF in the patients studied. It shows that smoking increased the risk of AHF by 3 in young patients, high atherogenic index of plasma by 4, high

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atherogenic coefficient by 3 and high hs-CRP by 3.

In elderly patients, factors associated with the occurrence of AHF were high blood pressure, smoking, high atherogenic coefficient and high hs-CRP. Multivariate analysis showed that smoking increased the risk of AHF 3, high atherogenic coefficient by 3 and high hs-CRP by 8. The association between high blood pressure and AHF did not persist after adjustment for confounding factors.

Multivariate analysis of STEMI patients' data showed that smoking increased the risk of AHF by 3, high atherogenic coefficient by 3 and high hs-CRP by 8.

Table 5. Bi- and multivariate analyses of factors associated with the occurrence of Acute heart failure

Variable	Age ≤ 55 years		Age > 55 years	
	bivariate analysis			
	P	OR (IC95 %)	p	OR (IC95 %)
Hypertension				
No		1		1
Yes	0.952	1.08 (0.94-2.33)	0.025	1.99 (1.15-3.96)
Smoking				
No		1		1
Yes	0.012	2.78 (1.59-7.21)	0.016	2.40 (1.18-4.87)
High AIP				
No		1		1
Yes	0.003	3.94 (2.35-5.02)	0.792	1.12 (0.47-2.68)
High AC				
No		1		1
Yes	0.026	3.39 (2.30-8.71)	0.007	3.16 (1.92-10.90)
hsCRP > 6 mg/dL				
No		1		1
Yes	0.016	2.04 (1.18-3.22)	<0.001	6.20 (2.60-14.81)
	multivariate analysis			
	P	ORa (IC95 %)	p	ORa (IC95 %)
Hypertension				
No		1		1
Yes	0.954	1.08 (0.74-1.84)	0.490	1.33 (0.59-2.99)
Tabac				
No		1		1
Yes	0.009	2.71 (1.72-3.77)	**0.028**	2.53 (1.11-5.78)
High AIP				
No		1		1
Yes	0.003	4.34 (2.27-7.25)	0.308	1.82 (0.57-2.79)
High AC				
No		1		1
Yes	0.046	2.75 (1.19-3.91)	**0.014**	3.11 (1.70-5.95)
hsCRP > 6 mg/dL				
No		1		1
Yes	0.039	3.19 (2.23-4.39)	**<0.001**	7.53 (2.92-9.45)

Discussion

This study aimed to compare characteristics and factors associated with acute complications in younger and older STEMI patients.

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The findings from our study provide important insights into the demographic, clinical, and biological characteristics of elderly and young patients hospitalized for STEMI.

Our results indicate significant differences in risk factors, clinical presentations, and outcomes between these two age groups, underscoring the necessity for tailored management strategies in clinical practice.

It is worth mentioning that there is no universal consensus regarding the cutoff age for differentiating young age and old age, with thresholds ranging from 45 to 85 years in various studies. The 55-year cut-off used in this study has been employed in others, such as the Atherosclerotic Cardiovascular Disease Study (ASCVD) (13) and Framingham Heart Study (14), which found that ACS incidence is higher in those over 55, with younger individuals (under 55) having distinct cardiovascular risk profiles, including less traditional risk factors and behavioural risk factors.

In this study, nearly one-third of patients (33.0%) were classified as young. Somme authors reported lower proportions (4), while others reported larger proportions (15), depending of the thresholds used to differentiate young from older patients.

In this study, smoking was the predominant CVRF, with 184(58.8%) patients being smokers. This is close to the 60% reported by Himbert *et al*. in an international registry (16), higher than the 42% of the 2015 FAST-MI register (17), but much lower than the 92.6% reported by Jousse-in-Remacle *et al* in a prospective French cohort of young subject with myocardial infarction (18). Smoking is a modifiable risk factor with a demonstrated causal link to atherosclerotic disease (19).

Smoking was observed in 76.0% of young people, compared to 50.2% of older people ($p<0.001$). A higher incidence of smoking among young STEMI patients was also found in other previous studies (20, 21), highlighting the critical contribution of smoking in to cardiovascular disease in these younger patients.

Conversely, a higher prevalence of hypertension was found in elderly patients compared to younger patients. This finding corroborates findings from previous studies (4, 15).

The differences in risk factor profiles reflect the varying of pathophysiological mechanisms involved in STEMI in young versus older patients. This suggests that prevention strategies should be more specific, focusing on smoking cessation and lifestyle changes for young people, while managing chronic conditions in the elderly.

A review by Alkhiary suggested that ACS in younger patients is primarily caused by acute events like thrombosis or plaque rupture, rather than atherosclerosis (22). These patients are more likely to have hypercoagulability and non-atherosclerotic coronary artery disease, including conditions like coronary vasospasm, cocaine abuse, and viral myocarditis, compared to older patients (23).

The study found no difference in traditional lipid abnormalities between younger and older STEMI patients. However, younger patients had a significantly higher prevalence of non-traditional lipid abnormalities, such as elevated AIP and AC, indicating a more pro-atherogenic lipid profile. These findings highlight the importance of including non-traditional lipid markers in cardiovascular risk assessments for younger patients.

Coronarography showed that most patients had a single lesion, with a notable prevalence of LAD involvement, consistent with other studies (24-25). The anterior STEMI predominance is mainly due to LAD occlusion, the dominant coronary artery. Notably, no significant differences in coronary lesion types were found between age groups in this study.

The study found heart rhythm disorders in 21.6% and AHF in 12.3% of patients, consistent with previous post-STEMI outcomes. AHF was more common in elderly patients, due to age-related factors like reduced cardiac reserve and increased susceptibility to structural heart changes, as also highlighted in studies like the Framingham Heart Study.

Cardiac rhythm disorders, such as UVT and AF, were seen at similar rates across age groups, though AF was more common in older patients. This aligns with existing literature linking AF to advanced age and increased stroke risk in elderly STEMI patients, as well as a higher incidence of AF and AHF in older adults post-myocardial infarction (26-27).

The present study revealed significant differences in factors associated with major complications found in young STEMI patients compared to older STEMI patients.

In patients aged 55 years or younger:

PAD increased the risk of arrhythmia by threefold, while a high AC and a high AIP doubled this risk. Smoking tripled the risk of HF, while a high AIP, a high AC, and high hsCRP quadrupled, tripled

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and tripled the risk, respectively. For elderly patients over 55 years old, diabetes mellitus tripled the risk of cardiac arrhythmias, ischemic heart disease doubled the risk, and a high CRI-II doubled the risk as well. Smoking tripled the risk of AHF, while a high AC tripled the risk, and high hs-CRP increased the risk by eightfold. The finding of PAD being a determinant of arrhythmia in young STEMI patients aligns with the analysis of Bekwelem *et al*. derived from the ARIC (Atherosclerosis Risk in Communities) Study, about the association between PAD and risk of new-onset AF(28). In this analysis, the authors reported that diagnosis of PAD according to an ankle-brachial index (ABI) classes is associated with an incident diagnosis of AF. There is further evidence for a strong relationship between PAD and FA (29). The data presented by the metaanalysis of poietti *et al.* suggest that the onset of the arrhythmia could be considered as the ultimate stage of a multiple-stage disease process, that starting from the presence of risk factors, leads to the development of atherosclerosis, diagnosis of PAD, and incident AF(29).

The associations between a high AC, high AIP, and arrhythmias suggest that lipid profile abnormalities are essential markers for identifying younger STEMI patients at higher risk for rhythm disturbances. The association between dyslipidemia and arrhythmia has been described for many decades (30), but it has so far been only for traditional dyslipidemia. In the present study, no association was found between traditional dyslipidemia while AC and AIP, two indices of atherogenicity were shown to be determinants of arrhythmia in young STEMI patients. This is another call for clinicians to go beyond the classic dyslipidemia to assess cardiovascular risk in STEMI patients. Inflammatory and endothelial changes induced by abnormal lipid metabolism are probably the link between dyslipidemia and arrhythmia.

Smoking was found to substantially increase the risk of AHF in this study. This finding is consistent with studies showing that smoking exacerbates endothelial dysfunction and left ventricular remodeling in younger individuals, increasing susceptibility to AHF even at earlier ages (31-32).

In elderly patients:

Diabetes mellitus (DM) was a strong predictor of arrhythmias, tripling the risk, while ischemic heart disease and the Castelli Risk Index II doubled the risk of cardiovascular complications. This supports evidence that DM and ischemic heart disease in older adults contribute to structural heart changes, increasing susceptibility to arrhythmias and poor outcomes. Smoking tripled the risk of AHF, consistent with its well-known role in cardiovascular diseases by promoting endothelial dysfunction, inflammation, and oxidative stress. The atherogenic coefficient, which reflects lipid metabolism disturbances, is a strong indicator of atherosclerosis and, in STEMI, worsens coronary damage, impairs myocardial perfusion, and increases AHF risk.

This study revealed that elevated hs-CRP, a marker of inflammation, is linked to an eightfold increased risk of AHF, highlighting inflammation's role in STEMI and AHF (33). It reflects ongoing myocardial injury and contributes to ventricular remodeling and impaired contractility (34), emphasizing the need for targeting inflammation in post-STEMI treatment (35).

Together, these results emphasize the necessity of addressing metabolic and inflammatory risk factors in elderly patients while prioritizing lipid management and smoking cessation interventions for younger patients to improve post-STEMI outcomes across different age groups.

Study Strengths and Limitations

This study is the first to demonstrate that acute STEMI complications and associated factors vary between young and older individuals$. However, it has limitations, including its post-hoc, cross-sectional design, which prevents causal conclusions, and potential selection bias from recruiting only at a single hospital.

Conclusion

This study highlights significant differences in cardiovascular risk factor profiles and complications between elderly and young patients with STEMI. Additionally, the study showed that young and older patients share some common risk factors for post-STEMI AHF, with one distinct risk factor for younger individuals: the atherogenic index of plasma. Furthermore, the determinants of post-STEMI heart rhythm disorders vary greatly between young and older patients. Further research is warranted to explore the underlying mechanisms and optimize treatment protocols for both age groups.

Conflict of interest

The authors declared that they have any conflict of interest.

Contribution for authors

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GIM and BKP wrote the first draft of the manuscript: ESK revised manuscript; GIM and JMMM prepared the database; AKN carried out the statistical analyses: GIM, JMMM, YMD, CKM, YMV, YLN, TMS, AKM, PG, SMG, TTM, FNN, ESK, and BKP have read and revised manuscript; ESK and BKP were scientific coordinator of the work.

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