



ST-segment elevation related differences in acute myocardial infarction presentation in young adults: the most frequent risk factors, clinical characteristics and significant findings

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ABSTRACT

Introduction: coronary heart disease is the leading cause of morbidity and mortality worldwide and although it primarily occurs in patients over the age of 40, younger men and women can be affected. This population account for only a small proportion of all patients with acute myocardial infarction (AMI) but is of particular interest because of the long and more active life expectancy.

Aim: to evaluate ST-segment elevation related differences of the most frequent risk factors and clinical characteristics in AMI in young adults.

Objectives: 1. to evaluate the differences of risk factors, clinical manifestation and lipidogram values among ST-elevation myocardial infarction (STEMI) and non ST-elevation myocardial infarction (NSTEMI) groups. 2. To evaluate the differences of angiographic and echocardiographic findings among STEMI and NSTEMI groups.

Methods: the retrospective data analysis of medical cases of 103 young patients of 40 years and under treated due to AMI in Kaunas Hospital of Lithuanian University of Health Sciences (LSMU), Cardiology department during the period of 2012 and 2017 years. The data of risk factors, clinical characteristics among young patients with AMI was analyzed. The patients were divided into STEMI and NSTEMI groups according electrocardiogram findings. The statistical analysis was performed using a standard statistical package SPSS 25.0.

Conclusions: 1. the presence of hyperlipidemia was the one risk factor that was significantly different among STEMI and NSTEMI groups and more frequent in NSTEMI group. NSTEMI was found to be associated with greater lipidogram values of total cholesterol and triglycerides. 2. According to angiographic findings, STEMI was associated with greater number of the segments affected during AMI. According to echocardiographic findings, STEMI was associated with lower left ventricular ejection fraction and more frequent presence of moderate left ventricular dysfunction, as well as lower left ventricle wall motion score index values.

Keywords: acute myocardial infarction, young patients, ST-segment elevation.

Introduction

Coronary heart disease (CHD) is the leading cause of morbidity and mortality worldwide (1) and although it primarily occurs in patients over the age of 40, younger men and women can be affected. Acute myocardial infarction (AMI) in young adults presents several peculiarities, represented not only by the risk profile, but also by the angiographic picture and the prognosis (2). According to different surveys (3, 4, 5), the incidence of AMI in young adults varies between 2% and 10%. This population account for only a small proportion of all patients with AMI but is of particular interest because of the long and more active life expectancy.

According to electrocardiography (ECG) findings, acute myocardial infarction is classified as ST-segment elevation (STEMI) and non-ST-segment elevation (NSTEMI) myocardial infarction. These two types of AMI differ not only in ECG and severity of coronary artery occlusions but also in clinical manifestations, choice of treatment tactics and prognosis (6).

In this paper we focused our attention on the cardiovascular risk factors and clinical characteristics of myocardial infarction in the young and their comparison according to the presence of STEMI and NSTEMI.

This study was conducted to learn the profile of the young patients (≤ 40 years) with acute myocardial infarction with an emphasis on: assessment of the risk factors, mode of presentation, coronary angiographic characterization and lipidogram values.

The aim of this work is to characterize the risk profile and factors influencing outcomes of these patients since it makes possible to manage prevention interventions.

Aim

To evaluate ST-segment elevation related differences of the most frequent risk factors and clinical characteristics in acute myocardial infarction in young adults.

Objectives

1. To evaluate the differences of the risk factors among STEMI and NSTEMI groups.
2. To evaluate the differences of clinical manifestation among STEMI and NSTEMI groups.
3. To evaluate the differences of angiographic and echocardiographic findings among STEMI and NSTEMI groups.

4. To evaluate the differences of lipidogram values among STEMI and NSTEMI groups

Methods

The retrospective data analysis of medical cases of 103 young patients of 40 years and under treated due to acute myocardial infarction in Kaunas Hospital of Lithuanian University of Health Sciences (LSMU), Cardiology department during the period of 2012 and 2017 years. The following data was collected: age, gender, electrocardiogram for ST-elevation MI (STEMI) or non ST-elevation MI (NSTEMI), localization of myocardial infarction, Killip classification of heart failure, smoking, arterial hypertension, diabetes mellitus, family history, body mass index (BMI), lipidogram (total cholesterol, low density lipoproteins (LDL), high density lipoproteins (HDL), triglycerides), peak values of diagnostic markers Troponin I and CRP, echocardiographic characteristics (left ventricle ejection fraction (LVEF), left ventricle end-diastolic diameter (LVEDD), left ventricle wall motion score index (WMSI), coronary artery angiography (CAA) characteristics (coronary artery disease, the number of segments affected significantly (with stenosis $\geq 75\%$), presence of coronary collaterals). Patients with BMI ≥ 25 kg/m² were considered overweight and with BMI ≥ 30 kg/m² – obese. Hyperlipidemia was present when total cholesterol values were $\geq 4,5$ mmol/l or LDL values were $\geq 3,0$ mmol/l. Heart failure was classified into four categories according to Killip classification. The statistical analysis was performed using a standard statistical package SPSS 25.0. Data significance was evaluated using χ^2 test and Mann-Whitney test. Data was considered statistically significant when p (significance level) value was < 0.05 .

Results

Demographic characteristics and cardiovascular risk factors are listed in Table 1. We examined 103 patients: 88 (85,4%) men and 15 (14,6%) women. The average age of the participants was $36,28 \pm 4,018$; age average of men was $35,98 \pm 4,174$, of women – $38,07 \pm 2,314$ years. There was no significant age difference among men and women ($p=0,062$).

The most frequent risk factors were cigarettes smoking (69,9%), arterial hypertension (66,0%), abnormal BMI including being obese or overweight (64,1%) and hyperlipidemia (59,2%).

Table 1. Demographic characteristics and cardiovascular risk factors (n=103)

Age (mean ± SD)	36,28±4,018
Male n (%)	88 (85,4%)
Female n (%)	15 (14,6%)
Smoking n (%)	72 (69,9%)
Family history of ischemic heart disease n (%)	39 (37,9%)
Hyperlipidemia n (%)	61 (59,2%)
BMI >30 Kg/m² n (%)	35 (34,0%)
BMI 25-29 Kg/m² n (%)	31 (30,1%)
BMI <25 Kg/m² n (%)	32 (31,1%)
Diabetes mellitus n (%)	9 (8,7%)
Hypertension n (%)	56 (54,4%)

Dividing our population according to BMI, 34,0% were obese, 30,1% were overweight and 31,1% had a normal BMI. Family history of ischaemic heart disease and diabetes were less frequent risk factors (37,9% and 8,7% respectively). Only 4 patients (3.9%) didn't present any of the studied cardiovascular risk factors.

Concerning clinical presentation, 73 patients (70,9%) were admitted with a STEMI, while 28 patients (27,2%) had a NSTEMI.

Table 2. Demographic characteristics and cardiovascular risk factors according to presentation of STEMI

	NSTEMI (n=28)	STEMI (n=73)	p value
Age (mean ± SD), years	36,79±3,83	36,04±4,13	0,272
Male n (%)	22 (78,6%)	65 (89,0%)	0,173
Female n (%)	6 (42,9%)	8 (57,1%)	
Smoking n (%)	24 (85,7%)	47 (64,4%)	0,194
Family history of ischemic heart disease n (%)	10 (35,7%)	28 (38,4%)	0,907
Hyperlipidemia n (%)	22 (78,6%)	38 (52,1%)	0,02
BMI >30 Kg/m² n (%)	13 (46,4%)	21 (28,8%)	0,208
BMI >25-29 Kg/m² n (%)	8 (28,6%)	22 (30,1%)	
BMI <25 Kg/m² n (%)	6 (21,4%)	26 (35,6%)	
Diabetes mellitus n (%)	1 (3,6%)	7 (9,6%)	0,328
Hypertension n (%)	17 (60,7%)	37 (50,7%)	0,091

Demographic characteristics and cardiovascular risk factors according to presentation of STEMI are represented in table 2. There were no significant differences found considering age, gender and principal cardiovascular risk factors among STEMI and NSTEMI groups ($p>0,05$) except for hyperlipidemia – it was significantly more frequent in NSTEMI group ($p=0,02$).

Table 3. Clinical presentation, diagnostic markers of myocardial infarction, angiographic and echocardiographic characteristics in all patients and in groups according to STEMI (n=103)

	All patients	NSTEMI (n=28)	STEMI (n=73)	p value
Killip class n (%)				0,089
First	34 (33,0%)	10 (35,7%)	24 (32,9%)	
Second	57 (55,3%)	12 (42,9%)	45 (61,6%)	
Third and fourth	9 (8,7%)	5 (17,9%)	4 (5,8%)	
Anterior infarction n (%)	55 (53,4%)	11 (39,3%)	42 (57,5%)	0,587
Inferior infarction n (%)	35 (34,0%)	9 (32,1%)	26 (35,6%)	
Troponin I (mean ± SD), µg/l	59,25±117,66	4,97±3,73	87,79±140,67	<0,001
CRP (mean ± SD), mg/l	33,0±62,6	9,9±6,9	22,31±56,39	0,237
One-vessel diseasen (%)	51 (49,5%)	12 (42,9%)	37 (50,7%)	0,235
Two-vessel diseasen (%)	23 (22,3%)	6 (21,4%)	17 (23,3%)	
Three-vessel diseasen (%)	15 (14,6%)	3 (10,7%)	12 (16,4%)	
Number of segments affected n (%):				0,04
None	11 (10,7%)	7 (25,0%)	4 (5,5%)	
One	43 (41,7%)	9 (32,1%)	33 (45,2%)	
Two	20 (19,4%)	4 (14,3%)	15 (20,5%)	
Three and more	29 (28,2%)	8 (28,6%)	21 (28,8%)	
Coronary collaterals n (%):				0,978
Not present	80 (77,7%)	22 (78,6%)	56 (76,7%)	
Present	14 (13,6%)	4 (14,3%)	10 (13,7%)	
LVEF (mean ± SD), %	44,57±10,39	52,0±3,61	39,39±9,83	<0,001
LVEF, %				<0,001
> 50% n (%)	46 (44,7%)	25 (89,3%)	20 (27,4%)	
< 50% n (%)	53 (51,5%)	1 (3,6%)	51 (69,9%)	
LVEDD (mean ± SD), mm	50,14±5,53	50,7±4,75	50,36±5,67	0,129
WMSI (mean ± SD)	1,62±0,43	1,2±0,11	1,73±0,39	<0,001

According to Killip classification among all participants, first class was diagnosed in 33% (n=34) of cases, second class – in 54,4% (n=56), the third and the fourth – 8,7% (n=9). MI localization was anterior in 55 subjects (53,4%), inferior – in 35 (34,0%). The average value of peak Troponin I was 59,25±117,66µg/l and of CRP – 33,0±62,6 mg/l. Young patients were more likely to have a single-vessel disease (49.5% of the sample, n=51), two vessel disease was noted in 22,3% (n=23) and three-vessel disease was seen in 14,6% (n=15) patients. Considering the number of the segments affected, the majority of patients had only one segment with significant stenosis (n=43, 41,7%), two segments were affected in 19,4% (n=20) of cases, three segments – in

20,4% (n=21), more than three – in 7,9% (n=8). Coronary collaterals were found in 14 number of cases (13,6%). Echocardiographic data were available for all 103 patients. The mean left ventricular ejection fraction (LVEF) was 44,57±10,39, and moderate left ventricular dysfunction (LVEF <50%) was present in 53 subjects (51.5%). The average of left ventricle end-diastolic diameter (LVEDD) was 50,14±5,53 and wall motion score index was 1,61±0,41.

Evaluating NSTEMI and STEMI groups, there were significant differences found in the values of peak Troponin I (p<0,001), in the number of segments affected (p=0,04), in mean LVEF (p<0,001), in presentation of moderate left ventricular dysfunction (p<0,001) and in WMSI (p<0,001) (table 3).

Table 4. Lipidogram characteristics in all patients and in groups according to STEMI (n=103)

	All patients	NSTEMI	STEMI	p value
Total cholesterol (mean ± SD), mmol/l	5,32±1,7	5,93±1,4	5,09±1,77	0,005
LDL (mean ± SD), mmol/l	3,28±1,34	3,73±1,26	3,09±1,35	0,016
HDL (mean ± SD), mmol/l	1,07±0,41	1,06±0,52	1,09±0,36	0,248
Triglycerides (mean ± SD), mmol/l	2,2±2,04	2,8±1,97	1,99±2,06	0,003

Among all patients the average of total cholesterol was 5,3±1,7 mmol/l, LDL 3,27±1,34 mmol/l, HDL 1,07±0,41 mmol/l, triglycerides 2,2±2,04 mmol/l. Evaluating lipidogram values among NSTEMI and STEMI groups (table 4), there were significant differences found in the values of total cholesterol (5,93±1,4 and 5,09±1,77 mmol/l respectively, p=0,005), LDL (3,73±1,26 and 3,09±1,35 mmol/l respectively, p=0,016) and triglycerides (2,8±1,97 and 1,99±2,06 mmol/l respectively, p=0,003) with greater values in NSTEMI group.

Discussion

In this study we performed a retrospective study enrolling young adults with ST elevation acute myocardial infarction or non-ST elevation acute myocardial infarction and examined cardiovascular risk factors, clinical presentation, angiographic and echocardiographic picture of a group of young patients hospitalized for a myocardial infarction. The data from literature indicates that about 10% of all patients hospitalized for acute myocardial infarction are young adults (2, 7). This prevalence shows that the onset of ischaemic heart disease in youngs is not rare and that the preventive methods are necessary to stop the incidences of AMI and the progress of CHD in older population. For evaluating AMI among the young most studies have used an age cut-off of 40 to 45 years to define "young" patients with AMI (1). The similar age definition – patients 40 years of age and under – was used in our research. The average age of the participants in our study was 36,28±4,018 and the majority of them (85,4%) were male, confirming the literature data (2, 8, 9, 10). Malik Fazila-Tun-Nesa and co-authors in their research found that young patients with AMI seem to have lower morbidity with the same mortality rates when compared with older ones (10). In agreement to previous reports, the majority of patients (70,9%) were admitted with a STEMI, while the minority of patients (27,2%) had a NSTEMI in our research. The presentation of STEMI in young adults varied in other studies from 58,3% to 95,16% (4, 11). However, there is limited data comparing STEMI and NSTEMI groups, especially in young patients diagnosed with AMI. In our study we not only examined the features of AMI among the young in general, but also compared the STEMI and

NSTEMI groups that reflect different severity of the myocardial damage.

According to the risk factors, numerous studies from literature suggested that acute myocardial infarction is the disease of men (8, 2, 9, 10). In agreement to this data, the majority of our patients (85,4%) were male. Considering other predispositions of AMI, we found that the most frequent risk factors among young patients were cigarettes smoking (69,9%), hyperlipidemia (59,2%), arterial hypertension (54,4%) and abnormal BMI including being obese (34,0%) or overweight (30,1%). Numerous studies confirmed that tobacco use is the main risk factor of AMI in young adults with percentages ranging from 62 to 90% (2, 10, 11, 12). The mechanisms of smoking in the development of CHI are still hypothesized and it is believed that smoking plays a role not only in atherogenesis, but also in thrombogenesis, as well as in the development of endothelial dysfunction, favoring coronary spasm (2). In our study, arterial hypertension was evaluated as the third most common risk factor, denying previous literature findings where it was less represented (2, 10, 13). In earlier studies obesity was not as common risk factor among the young, with percentages ranging 3,3-20% (5, 10), whereas in our study it was present in 34% of cases. Heart failure was classified into four categories according to Killip classification. The first class of Killip was diagnosed in 33% of cases, second class – in 54,4%, the third and the fourth – 8,7%. The first and the second class of Killip was found most common among young patients with AMI and in other similar studies (11, 13). According to angiographic findings, the majority of young patients in our study had a single-vessel disease (49,5%), while two vessel disease was noted in 22,3% and three-vessel disease was seen in 14,6% of patients. Considering the number of the segments affected, presentation of one segment with significant stenosis was the most common in our patients (41,7%). Our data confirmed previous literature studies where multivessel and three-vessel disease was found to be less frequent in the younger population (6, 14). Incalcaterra et al. in their research confirmed that young patients generally show a less evolved atherosclerotic disease (2). This likely due to a number of factors including age and

comorbidities such as increased prevalence of hypertension and diabetes in the older patients. In our study, hyperlipidemia was one of the most frequent risk factor among the young patients with AMI, noted in 59.2% of cases, and the second after smoking that was noted in 69.9% of cases. Hyperlipidemia as the second most common risk factor is consisted with other literature findings (2, 10), and the results of Lipid Research Clinics Trial (15) demonstrated a direct association between the plasma lipoprotein profile, the cholesterol levels and the morbidity and mortality from coronary atherosclerosis. The exceptional feature in our study is that hyperlipidemia was significantly more frequent in NSTEMI group: 78,6% vs 52,1% in STEMI group ($p=0.02$), while smoking and the other risk factors did not differ among the groups. There was also a tendency for obesity ($BMI >30 \text{ Kg/m}^2$) to be more present in NSTEMI group, but this difference was not significant. Evaluating NSTEMI and STEMI groups, there were significant differences found in the values of total cholesterol, LDL and triglycerides, with greater values in NSTEMI group ($p<0.05$). This is unusual as hyperlipidemia is associated with atherosclerosis and deeper damage to myocardial tissue that leads to clinical presentation as STEMI (8). This finding also suggests that hyperlipidemia (elevated cholesterol values, LDL and triglycerides) are the leading cause for NSTEMI myocardial infarction. Disorders of dyslipidemias are of great genetic predisposition, as genetic dyslipidemias contribute to the prevalence of ischemic heart disease (16, 17), therefore family history of ischaemic heart disease may play a significant role in early diagnosis and prevention of AMI. Literature findings highlight that significantly higher levels of total cholesterol and higher proportions of hyperlipidemia, risk conditions for development of premature coronary disease, are more common among young patients with AMI than the older ones (8, 18, 19). It can be added that when compared to older patients, young patients have lower mean serum high density lipoprotein (HDL) concentrations and higher serum triglycerides (1). Accordingly, hyperlipidemia is of greater importance among the young, and our findings show that it has a tendency to manifest as a NSTEMI form of myocardial infarction more frequently. Moreover, presence of dyslipidemia is a risk factor for repeated MI and, consequently, is associated with worse prognosis (20). According to echocardiographic findings, there was a significant difference of LVEF among the groups – in STEMI group LVEF percentages were significantly lower ($p<0,001$). The number of cases with mild left ventricular dysfunction ($LVEF<50\%$) was also more frequent in STEMI group. Incalcaterra et al. examined risk factors that

were associated with the recurrence of AMI among the young, and found that decreased ejection fraction was related to the recurrence of acute coronary events, while presence of healthy coronary arteries has a positive prognostic impact at long time follow-up (2). According to our results, patients of the STEMI group have a greater risk of facing AMI in the future. What we also found was that WMSI values were significantly lower in STEMI group – thus, there is a tendency for echocardiographic values to be of bigger change in the presence of ST-segment elevation. In conclusion, premature coronary disease is a frequent entity that affects predominantly the male sex and shows high prevalence of cardiovascular risk factors, mainly tobacco usage, hyperlipidemia and arterial hypertension. In addition, it is characterised by a less extensive coronary atherosclerosis, mainly with higher presence of single-vessel disease in contrast to older patients. Evaluating NSTEMI and STEMI groups, there were significant differences in the presence of hyperlipidemia in NSTEMI group, including changes in lipidogram, also in values of the peak Troponin I, in the number of segments affected ($p=0,04$), in mean LVEF ($p<0,001$), in presentation of moderate left ventricular dysfunction ($p<0,001$) and in WMSI ($p<0,001$). We did not find substantial literature studies where STEMI and NSTEMI groups were compared among the young, thus this is a relatively new perspective. The study of ischemic heart disease in young individuals is important in the era of preventive cardiology. Taking into account that the early onset of ischemic heart disease is not so rare, the evaluation of its risk profile, clinical features and prognosis may have a relevant clinical impact for risk factors modification and for the improvement of primary and secondary prevention.

Conclusions

1. The presence of hyperlipidemia was the one risk factor that was significantly different among STEMI and NSTEMI groups, and more frequent in NSTEMI group.
2. Clinical manifestation according Killip class and localization of MI did not differ among the groups, but peak Troponin I values were significantly greater in the STEMI group.
3. According to angiographic findings, STEMI was associated with greater number of the segments affected during MI. According to echocardiographic findings, STEMI was associated with lower LVEF and more frequent presence of moderate left ventricular dysfunction, as well as lower WMSI values.
4. NSTEMI was found to be associated with greater lipidogram values of total cholesterol, LDL and triglycerides.

Gratitude

We are grateful to Gediminas Jaruševičius, a cardiology professor of Lithuanian University of Health Sciences, for consulting us on this topic and cooperation during the process.

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