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Relationship between low-density lipoprotein cholesterol level on admission and in-hospital mortality in patients with ST-segment elevation myocardial infarction, with or without diabetes, treated with percutaneous coronary intervention

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Abstract

Background: Low-density lipoprotein cholesterol (LDL-C) is the independent risk factor for coronary artery disease. Diabetes mellitus (DM) is associated with poor outcome in patients with ST-segment elevation myocardial infarction (STEMI) treated with percutaneous coronary interventions (PCI). The relationship between LDL-C and mortality in patients with STEMI has not been well established.

Aim: To assess whether the LDL-C level on admission can predict in-hospital mortality in patients with or without DM treated with PCI for STEMI.

Methods: 1808 consecutive patients with STEMI (378 with DM) treated with PCI were included in the analysis. Patients were divided according to the presence of DM and LDL-C level on admission with a threshold of 3.7 mmol/L (143 mg/dL). In the diabetic group there were 208 patients with LDL-C < 3.7 mmol/L (143 mg/dL) and 170 with LDL-C ≥ 3.7 mmol/L (143 mg/dL), whereas in the non-diabetic group 726 and 704 patients, respectively. We analysed the effects of LDL-C level and various risk factors on in-hospital mortality separately for patients with or without DM.

Results: The mean total cholesterol (5.6 ± 1.4 *vs* 5.7 ± 1.5 mmol/L; 216.6 ± 54.1 *vs* 220.4 ± 58 mg/dL, p = 0.21), LDL-C (3.6 ± 1.3 *vs* 3.7 ± 1.5 mmol/L; 139.2 ± 50.3 *vs* 143.0 ± 58 mg/dL, p = 0.11) and triglyceride level (1.7 ± 0.6 *vs* 1.6 ± ± 0.5 mmol/L; 150 ± 52.9 *vs* 141.2 ± 44.1 mg/dL, p = 0.30) were similar in patients with or without DM, whereas HDL-C level was lower in diabetic patients (1.4 ± 0.6 *vs* 1.8 ± 0.5 mmol/L; 53.7 ± 23.0 *vs* 69 ± 19.2 mg/dL, p = 0.049). The in-hospital mortality was 6.1% and 3.2%, for patients with or without DM, respectively (p = 0.008). In the diabetic group in-hospital mortality was higher in patients with LDL-C level on admission ≥ 3.7 mmol/L (143 mg/dL) in comparison to the patients with LDL-C < 3.7 mmol/L (143 mg/dL; 7.1% *vs* 4.8%; p = 0.03). The multivariate analysis revealed that in diabetics an increase in LDL-C level on admission by 1 mmol/L (38.67 mg/dL) was related to a 45% increase in in-hospital mortality (OR 1.45, 95% CI 1.10—2.00, p = 0.023). In the non-diabetic group in-hospital mortality was similar in patients with LDL-C level on admission ≥ 3.7 mmol/L (143 mg/dL) and < 3.7 mmol/L (143 mg/dL); 2.6% *vs* 3.7%; p = 0.21. In multivariate analysis LDL-C level was not related with in-hospital mortality in patients without DM (per 1 mmol/L; 38.67 mg/dL); OR 0.95, 95% CI 0.70–1.27, p = 0.71.

Conclusions: Elevated LDL-C level on admission is associated with increased in-hospital mortality in diabetic but not in non-diabetic patients treated with PCI for STEMI.

Key words: low-density lipoprotein cholesterol, myocardial infarction, diabetes mellitus

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Table 1. Baseline characteristics of the included and excluded study groups

Parameter	Study group (n = 1808)	Excluded patients (n = 1357)	P
Age [years]	59.5 ± 11.2	58.1 ± 11.3	0.0006
Females	507 (28.0%)	348 (25.6%)	0.14
Hypertension (3147 pts)	997 (55.4%)	683 (50.7%)	0.01
Hypercholesterolaemia (3144 pts)	1082 (60.0%)	767 (56.5%)	0.1
Smoking (3126 pts)	1066 (59.8%)	821 (61.2%)	0.42
Diabetes	378 (20.9%)	266 (19.6%)	0.35
Previous MI (3153 pts)	319 (17.7%)	278 (20.5%)	0.049
Fibrinolysis prior to PCI	215 (11.9%)	460 (33.9%)	0.0001
Cardiogenic shock	151 (8.4%)	161 (11.9%)	0.001
Anterior wall MI	725 (40.1%)	562 (41.4%)	0.45
Initial TIMI 0–1 flow (3094 pts)	1454 (81.5%)	859 (65.6%)	0.0001
Multivessel coronary artery disease (3042 pts)	876 (49.6%)	623 (48.4%)	0.65
Stent implantation (3152 pts)	1483 (82.4%)	780 (57.7%)	0.00001
Final TIMI 3 flow (3093 pts)	1584 (88.8%)	1140 (87.1%)	0.15
In-hospital mortality	68 (3.8%)	109 (8.0%)	0.00001

PCI — percutaneous coronary intervention; MI — myocardial infarction; TIMI — Thrombolysis In Myocardial Infarction

INTRODUCTION

Diabetes mellitus (DM) is an independent risk factor of coronary artery disease (CAD) [1] and adverse outcomes in this group of patients. It has been shown that mortality of diabetic patients with CAD equals the mortality of patients who suffered from myocardial infarction (MI) [2]. Diabetes worsens the in-hospital outcomes and long-term clinical outcomes in patients with MI [3–5]. Furthermore, DM is associated with the presence of dyslipidaemia. Patients with DM have higher triglyceride level, lower high-density cholesterol (HDL-C) level, comparable total cholesterol and low-density cholesterol (LDL-C) [6]. An elevated LDL-C increases the risk of CAD in such patients [7]. It has been shown that LDL-C is an independent predictor of MI [8]. There are also theories suggesting that LDL-C may determine mortality of patients with MI [9–13]. However, there is no knowledge determining the influence of LDL-C on mortality of patients with MI and with or without DM.

Therefore, the aim of our study was to assess whether the LDL-C level on admission can affect in-hospital mortality in patients with and without DM treated with percutaneous coronary intervention (PCI) for ST segment elevation myocardial infarction (STEMI).

METHODS

Study group

We analysed retrospectively 3165 consecutive patients with STEMI treated with PCI in our department between 1998––2006. We excluded 1357 patients with unavailable LDL-C level on admission. The remaining 1808 patients were included into the analysis. Baseline characteristics of included and excluded patients are shown in Table 1.

Urgent coronary angiography was performed in patients with continuing anginal pain lasting ≥ 30 min, electrographic pattern of acute MI, i.e. ST segment elevation ≥ 0.1 mV in ≥ 2 limb leads or ≥ 0.2 mV in ≥ 2 precordial leads or a new left bundle branch block, with the time from onset of symptoms to revascularisation not exceeding 12 hours. Epicardial coronary artery flow was assessed using the Thrombolysis in Myocardial Infarction (TIMI) scale [14]. Successful PCI was defined as TIMI 3 flow with residual stenosis ≤ 30% without the evidence of flow-limiting dissection. After PCI all study patients were transferred to an intensive cardiology care unit. In case of reoccurrent pain and ST segment elevation, the study patients were referred for immediate coronary angiography, and repeat PCI was performed if re-occlusion or significant stenosis of the infarct-related artery was discovered.

During the following days, patients received aspirin, ticlopidine or clopidogrel, beta-blockers, angiotensin-converting enzyme inhibitors, and statins if not contraindicated.

All patients with DM or hyperglycaemia during an acute phase of MI without previous diagnosis of DM were treated with short-acting insulin given intravenously or subcutaneous. In patients with DM diagnosed following the acute phase of MI, we initiated oral hypoglycaemic medications and diet, if the daily insulin requirement was less than 30 U. In patients with DM diagnosed after an acute phase of MI, we used the treatment prior to the MI, if the daily insulin requirement was less than 30 U. All the other remaining DM patients received insulin in multiple daily injections.

Left ventricular ejection fraction (LVEF) was assessed prior to the hospital discharge. Baseline clinical and angiographic characteristics, in-hospital clinical outcomes were recorded in the study database.

LDL-C level on admission

The LDL-C level on admission was measured in the emergency room. The LDL-C was calculated using the Friedewald equation, if triglycerides were < 4 mmol/L (350 mg/dL). In all remaining patients the LDL-C was measured using the colorimetric enzymatic test.

Analysed groups

The first grouping criterion was presence or lack of DM. Diabetic patients were defined based on the medical history of DM (documented DM treated with insulin or oral hypoglycaemic medications or diet) and increased blood glucose during the hospitalisation (≥ 2 measurements of fasting blood glucose ≥ 7 mmol/L (126 mg/dL) after the acute phase of MI or blood glucose ≥ 11.1 mmol/L (200 mg/dL) in the oral glucose tolerance test (OGTT) performed prior to the hospital discharge. There were 378 patients with DM and 1430 without DM.

Second grouping criterion was LDL-C level on admission with a threshold of 3.7 mmol/L (143 mg/dL). The whole study group mean LDL-C and median LDL-C were 3.71 mmol/L (143.5 mg/dL) and 3.66 mmol/L (141.5 mg/dL), respectively. In diabetic group there were 208 patients with LDL-C < 3.7 mmol/L (143 mg/dL) and 170 with LDL-C ≥ 3.7 mmol/L (143 mg/dL), whereas in non-diabetic group 726 and 704 patients, respectively. The study groups were formed regardless of the hypercholesterolaemia presence. Hypercholesterolaemia was defined based on the medical history (hypercholesterolaemia and lipid lowering therapy) and increased total cholesterol levels during the hospitalisation (> 5.2 mmol/L; 200 mg/dL).

Statistical analysis

Normally distributed continues variables are presented as means ± standard deviations. Differences in mean values were compared using the Student-t test. Categorical variables were compared using the χ^2 test (with Yates correction if the expected number of observations was less than 5). The effects of evaluated parameters on mortality were assessed using the multivariate logistic regression with results expressed as odds ratios (OR) and 95% confidence intervals (CI). A two-sided p value < 0.05 was considered statistically significant. Multivariate analysis included variables, which were statistically significant in univariate analysis. Due to a possible linear relationship between mortality and LDL-C, the LDL-C was considered as a continuous variable. All calculations and analyses were performed using Statistica PL software, version 7.0 (StatSoft Inc.).

RESULTS

There were important differences between the excluded and included patients. The excluded patients were younger, more likely to be treated with fibrinolysis prior to PCI, with the medical history of MI or cardiogenic shock, but less likely to be hypertensive. They also had lower rates of initial TIMI 0–1 flow in the infarct-related artery and stent implantation, and higher in-hospital mortality rates, when compared to the included patients (Table 1). Mortality rates were comparable regardless of the LDL-C level (≥ 3.7 mmol/L and < 3.7 mmol/L; 3.4% *vs* 4.1%; p = 0.47, respectively). Similarly, in-hospital mortality did not differ between the groups of patients with HDL-C < 1.6 mmol/L and ≥ 1.6 mmol/L (4.0% and 3.2%; p = 0.46, respectively). The mean total cholesterol (5.6 ± ± 1.4 *vs* 5.7 ± 1.5 mmol/L; 216.6 ± 54.1 *vs* 220.4 ± 58 mg/dL; p = 0.21), LDL-C (3.6 ± 1.3 *vs* 3.7 ± 1.5 mmol/L; 139.2 ± ± 50.3 *vs* 143.0 ± 58 mg/dL; p = 0.11) and triglycerides level (1.7 ± 0.6 *vs* 1.6 ± 0.5 mmol/L; 150 ± 52.9 *vs* 141.2 ± ± 44.1 mg/dL; p = 0.30) were similar in patients with and without DM, whereas HDL-C level was lower in diabetic patients (1.4 ± 0.6 *vs* 1.8 ± 0.5 mmol/L; 53.7 ± 23.0 *vs* 69 ± ± 19.2 mg/dL; p = 0.049). The mean in-hospital mortality was 6.1% and 3.2%, respectively for patients with and without DM (p = 0.008).

Diabetic patients

Baseline characteristics. The patients with elevated LDL-C (≥ 3.7 mmol/L) were more likely to be hypercholesterolaemic, females, with increased blood glucose on admission, when compared to the patients with lower LDL-C (< 3.7 mmol/L). There was a trend towards lower rates of hypertension and smoking in such patients. Baseline characteristics of the study groups are shown in Table 2. Pharmacotherapy during hospitalisation is shown in Table 3.

Angiographic characteristics. Coronary angiography showed no significant differences in rates of baseline TIMI 0–1 flow in the infarct-related artery, multivessel CAD, stent implantation and post-TIMI 3 flow rates between the study groups. Angiographic characteristics of the study groups are shown in Table 2.

In-hospital follow-up data. Multivariate analysis. The patients with higher LDL-C level on admission (≥ 3.7 mmol/L) had increased CK-MB and lower LVEF, when compared to the patients with lower LDL-C levels on admission (< 3.7 mmol/L). The rates of use of statins were comparable between the study groups. In-hospital mortality was higher in patients with elevated LDL-C level. In-hospital data of the study groups are shown in Table 4. The multivariate analysis revealed that each increase in LDL-C on admission by 1 mmol/L (38.67 mg/dL) was related to an increase in in-hospital mortality (OR 1.45, 95% CI 1.10–2.00, p = 0.023). Furthermore, other independent prognostic factors of increased in-hospital mortality were as follows: age, cardiogenic shock and LVEF (Table 5).

Table 2. Baseline clinical and angiographic characteristics of the study groups

Parameter	Diabetic patients			Non-diabetic patients		
	LDL < 3.7 mmol/L (143.0 mg/dL) N = 208	LDL ≥ 3.7 mmol/L (143.0 mg/dL) N = 170	P	LDL < 3.7 mmol/L (143.0 mg/dL) N = 726	LDL ≥ 3.7 mmol/L (143.0 mg/dL) N = 704	P
Age [years]	64.0 ± 10.6	64.4 ± 9.5	0.74	58.9 ± 11.6	57.5 ± 10.6	0.02
Females	76 (36.5%)	90 (52.9%)	0.001	175 (24.1%)	166 (23.6%)	0.80
Hypertension (1801 pts)	164 (78.9%)	121 (71.2%)	0.09	369 (51.3%)	343 (48.8%)	0.35
Hypercholesterolaemia	99 (47.6%)	134 (78.8%)	0.0001	331 (45.6%)	521 (74.0%)	0.0001
Smoking (1784 pts)	89 (43.4%)	58 (34.3%)	0.07	451 (63.3%)	468 (67.1%)	0.13
Previous MI (1798 pts)	50 (24.3%)	35 (20.6%)	0.4	136 (18.9%)	98 (14.0%)	0.01
Mean time from the onset of symptoms to admission [h] (1485 pts)	7.6 ± 4.1	6.3 ± 3.7	0.22	5.4 ± 3.4	5.6 ± 3.1	0.59
Anterior wall MI	81 (38.9%)	72 (42.0%)	0.55	272 (37.5%)	301 (42.7%)	0.046
Fibrinolysis prior to PCI	23 (11.1%)	21 (12.4%)	0.69	82 (11.3%)	89 (12.7%)	0.43
Mean blood glucose on admission [mmol/L; mg/dL] (1518 pts)	11.9 ± 5.3; 214.2 ± 95.4	13.1 ± 5.2; 235.8 ± 93.6	0.02	8.1 ± 3.3; 145.8 ± 59.4	8.0 ± 2.7; 144 ± 48.6	0.53
Cardigenic shock	20 (9.6%)	18 (10.6%)	0.75	67 (7.2%)	46 (6.5%)	0.23
Infarct-related artery (1768 pts)			0.21			0.53
RCA	98 (48.3%)	69 (41.1%)		301 (42.9%)	275 (39.%)	
Cx	26 (12.8%)	28 (16.7%)		113 (16.1%)	128 (18.4%)	
LAD	79 (38.9%)	69 (41.1%)		284 (40.5%)	287 (41.3%)	
LM	0 (0%)	2 (1.2%)		4 (0.6%)	5 (0.7%)	
Initial TIMI 0–1 flow	178 (85.6%)	135 (79.4%)	0.13	581 (80.0%)	582 (82.6%)	0.15
Multivessel coronary artery disease	118 (56.7%)	99 (58.3%)	0.79	338 (46.6%)	341 (48.4%)	0.51
Stent implantation	170 (81.7%)	140 (82.4%)	0.94	590 (81.3%)	589 (83.7%)	0.23
Final TIMI 3 flow [%]	180 (86.5%)	141 (82.9%)	0.33	649 (89.4%)	636 (90.3%)	0.57

LDL — low-density lipoproteins; MI — myocardial infarction; RCA — right coronary artery, Cx — circumflex artery, LAD — left anterior descending artery; LM — left main, rest of abbreviations as in Table 1

Table 3. Pharmacological therapy during hospitalisation

Parameter	Diabetic patients			Non-diabetic patients		
	LDL < 3.7 mmol/L (143.0 mg/dL) N = 208	LDL ≥ 3.7 mmol/L (143.0 mg/dL) N = 170	P	LDL < 3.7 mmol/L (143.0 mg/dL) N = 726	LDL ≥ 3.7 mmol/L (143.0 mg/dL) N = 704	P
Aspirin (1435 pts)	174 (95.6%)	139 (95.2%)	0.86	532 (96.7%)	550 (98.7%)	0.02
Thienopyridines (1463 pts)	149 (79.7%)	120 (81.6%)	0.65	456 (81.0%)	486 (85.8%)	0.03
Beta-blockers (1478 pts)	174 (92.1%)	133 (88.7%)	0.29	516 (90.4%)	541 (95.3%)	0.001
Calcium channel blockers (1465 pts)	19 (9.1%)	24 (14.1%)	0.11	66 (9.1%)	54 (7.7%)	0.32
Nitrates (1454 pts)	139 (74.7%)	111 (75.7%)	0.87	406 (72.4%)	411 (73.4%)	0.70
ACE inhibitors (1462 pts)	150 (79.8%)	114 (77.0%)	0.54	402 (71.5%)	420 (74.5%)	0.27
Statins (1473 pts)	161 (86.1%)	135 (90.0%)	0.28	653 (89.9%)	648 (92.0%)	0.13

ACE — angiotensin-converting enzyme

Table 4. In-hospital data

Parameter	Diabetic patients			Non-diabetic patients		
	LDL < 3.7 mmol/L (143.0 mg/dL) N = 208	LDL ≥ 3.7 mmol/L (143.0 mg/dL) N = 170	P	LDL < 3.7 mmol/L (143.0 mg/dL) N = 726	LDL ≥ 3.7 mmol/L (143.0 mg/dL) N = 704	P
Peak CK-MB [IU/L] (1491 pts)	152.7 ± 138.3	210.0 ± 194.8	0.004	185.7 ± 145.7	223.9 ± 165.5	0.002
LVEF [%] (1692 pts)	42.0 ± 9.2	38.1 ± 8.8	0.049	45.0 ± 8.5	44.9 ± 8.2	0.89
Gastrointestinal bleeding	9 (4.3%)	9 (5.3%)	0.24	24 (3.3%)	25 (3.5%)	0.81
Post PCI hematoma (1786 pts)	4 (1.9%)	6 (3.6%)	0.32	12 (1.7%)	15 (2.2%)	0.53
Blood transfusion (1784 pts)	7 (3.4%)	9 (5.4%)	0.35	18 (2.5%)	22 (3.2%)	0.47
Urgent CABG (1694 pts)	3 (1.5%)	2 (1.2%)	0.80	14 (2.1%)	7 (1.1%)	0.13
Routine CABG (1804 pts)	15 (7.2%)	10 (6.0%)	0.63	32 (4.4%)	35 (5.0%)	0.63
Re urgent PCI (1806 pts)	18 (8.7%)	15 (8.9%)	0.94	48 (6.6%)	39 (5.5%)	0.39
Routine PCI [%]	22 (10.6%)	12 (7.1%)	0.23	71 (9.8%)	84 (11.9%)	0.19
Cerebrovascular event during hospitalisation [%]	8 (3.9%)	6 (3.5%)	0.87	15 (2.1%)	12 (1.7%)	0.11
Supraventricular arrhythymias (1515 pts)	21 (10.1%)	15 (8.8%)	0.43	59 (8.1%)	47 (6.7%)	0.11
Ventricular arrhythmias (1515 pts)	26 (13.5%)	23 (14.7%)	0.75	85 (14.6%)	63 (10.8%)	0.21
Duration of hospitalisation [days]	8.2 ± 4.9	8.2 ± 5.1	0.29	7.9 ± 5.0	7.4 ± 4.3	0.03
In-hospital mortality	10 (4.8%)	12 (7.1%)	0.03	27 (3.7%)	18 (2.6%)	0.21

All data presented as numbers of patients and % (in parenthesis) unless specified otherwise; LDL — low-density lipoproteins, PCI — percutaneous coronary intervention, CABG — coronary artery bypass grafting surgery

Table 5. Prognostic factors of in-hospital mortality in patients with or without diabetes mellitus. Multivariate analysis

Diabetes mellitus (n = 378)			No diabetes mellitus (n = 1430)		
Parameter	OR (95% CI)	P	Parameter	OR (95% CI)	P
Cardiogenic shock	2.89 (1.81–4.63)	0.02	Cardiogenic shock	4.04 (2.03–6.10)	0.02
LDL-C level on admission (per 1 mmol/L [38,67 mg/dL])	1.45 (1.10–2.00)	0.023	LDL-C level on admission (per 1 mmol/L [38.67 mg/dL])	0.97 (0.74–1.26)	0.81
Age [per 1 year]	1.17 (1.02–1.34)	0.03	Age	1.04 (1.01–1.07)	0.03
LVEF [per 1%]	0.96 (0.94–0.98)	0.001	Anterior wall MI	3.62 (1.84–7.13)	0.0001
			Blood glucose on admission (per 1 mmol/L [18 mg/dL]	1.13 (1.05–1.20)	0.0004
			Final TIMI 3 flow	0.51 (0.26–0.99)	0.048
			Stent implantation	0.23 (0.11–0.50)	0.0001

LDL — low-density lipoproteins; MI — myocardial infarction; TIMI — Thrombolysis In Myocardial Infarction; LVEF — left ventricular ejection fraction

Non-diabetic patients

Baseline characteristics. The group of patients with elevated LDL-C was younger, more likely to present with hypercholesterolaemia and MI, and less likely to have a medical history of MI, when compared to the patients with lower LDL-C level. Baseline characteristics of the study groups are shown in Table 2. Pharmacotherapy during hospitalisation is shown in Table 3.

Angiographic characteristics. Similarly to the diabetic patients, coronary angiography showed no significant differences in rates of initial TIMI 0–1 flow, multivessel CAD, stent implantation and post-TIMI 3 flow rates between the study groups. Angiographic characteristics of the study groups are shown in Table 2.

In-hospital follow-up data. Multivariate analysis. The patients with elevated LDL-C level on admission (≥ 3.7 mmol/L) had increased CK-MB, higher rates of aspirin, thienopyridines and beta-blockers usage during hospitalisation. However, the rates of statins were comparable between the study groups. In contrast to the patients with DM, the in-hospital mortality

was comparable regardless of the LDL-C level on admission. The in-hospital data of the study groups are shown in Table 4. In multivariate analysis LDL-C level was not associated with in-hospital mortality (per 1 mmol/L, 38.67 mg/dL; OR 0.95; 95% CI 0.70–1.27; p = 0.71). Furthermore, other independent prognostic factors of increased in-hospital mortality were cardiogenic shock, anterior MI, blood glucose level on admission, age, final TIMI flow in the infarct-related artery and stent implantation (Table 5).

DISCISSION

Our study showed that DM patients with elevated LDL-C level (≥ 3.7 mmol/L) had significantly higher mortality rates whereas in non-DM patients LDL-C level was not associated with mortality. The multivariate analysis revealed that each increase of LDL-C level by 1 mmol/L (38.67 mg/dL) was related to an increased in in-hospital mortality by 45%.

Patients with DM have comparable LDL-C levels to those without DM [6]. However, it has been shown that LDL-C particles in patients with DM have less cholesterol than apopoprtotein B-100, which is caused by the triglyceridaemia, characteristically present in patients with DM. Therefore, more potent atherogenic and thick LDL-C particles are formed in patients with DM, when compared to the non-diabetic patients. Small diameter of the LDL-C particles enhances the artery wall penetration and further oxidation of these particles. Furthermore, small LDL-C particles have lower affinity to the LDL-C particle receptor, which increases the time of circulation in the blood serum and formation of the atherogenic plaques in the vessel walls [15]. Importantly, patients with DM and elevated LDL-C levels on admission, have larger MI and lower LVEF, which was documented in our study.

It is important to emphasise that there is a significant lack of research describing the effects of the LDL-C level on admission on the in-hospital mortality in patients with DM suffering from an MI. There are only few studies describing this relationship besides diabetic patients. The results are discordant. Al-Mallah et al. [9] showed that 3-year mortality in patients with NSTEMI and LDL-C ≤ 105 mg/dL was significantly higher compared to patients with LDL-C > 105 mg/dL. Similarly, Wang et al. [12] in univarariate analysis revealed LDL-C ≥ 100 mg/dL (2.6 mmol/L) to be an independent predictor of lower in-hospital mortality in NSTEMI patients without hypercholesterolaemia. However, the multivariate analysis did not confirm this relationship. Opposite results were presented in the Myocardial Ischaemia Reduction with Aggressive Cholesterol Lowering (MIRACL) trial. The multivariate analysis revealed that LDL-C level was not associated with increased risk of the combined endpoint (death, MI, cardiac arrest and urgent revascularisation) in patients with acute coronary syndrome during 16 months of follow up [11]. Akosah et al. [10] presented similar results. The authors analysed patients who have not been treated with lipid lowering medication previously, who were then further stratified into two groups based on the LDL-C levels: ≤ 100 mg/dL and LDL-C ≥ 160 mg/dL. Both 30-day mortality and 1-year mortality rates were comparable between the study groups. Importantly, all the above analyses used the LDL-C level measured during the following days of hospitalisation. Thus, the LDL-C levels were considerably lower than in our analysis. The relationship between clinical outcomes and the initial LDL-C levels were analysed by Correia et al. [13]. The authors showed no relationship between LDL-C and in-hospital adverse outcomes (death, MI, recurrent ischaemia) based on 97 patients with NSTEMI. However, the authors reported that the HDL-C level on admission was an independent predictor of adverse outcomes, with no effect on in-hospital mortality. The study included patients regardless of the cholesterol levels. Importantly, hypercholesterolaemia did not turn out to be an independent predictor of higher in-hospital mortality rates. In contrary, Wang et al. [12] presented evidence that hypercholesterolaemia was an independent predictor of lower in-hospital mortality in patients with NSTEMI. It might be due to the fact that the study group was under continuous medical care consisting of the lipid lowering medications and treatment plans to fight with other coexisting diseases and conditions. There is no clear explanation why hypercholesterolaemia turned out not to be the determinant of mortality.

Based on the presented evidence, it seems that LDL-C level on admission plays an important prognostic role in patients with MI and DM, and thus, the aggressive lipid lowering therapy should be implemented in this group of patients.

Limitations of the study

Our study represents a single centre, retrospective registry analysis. The LDL-C concentrations on admission were available in 57% of all patients. There is a lack of data on lipid lowering treatment prior to the hospitalisation. Although during the hospitalisation the rates of statins were comparable between the study groups, we do not know the exact dosing nor whether the therapy was effective (lack of cholesterol level checks throughout the hospitalisation). It is important to emphasise, that all available reports analysing the influence of cholesterol level on clinical outcomes have also limited pharmacotherapy data [9, 10, 12]. The other possible limitation of the presented study is that we described the relationship between LDL-C level on admission and in-hospital mortality only.

CONCLUSIONS

Elevated LDL-C level on admission is associated with increased in-hospital mortality in patients with DM, but not in non-diabetic patients treated with PCI for STEMI.

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Wpływ stężenia cholesterolu LDL przy przyjęciu na śmiertelność wewnątrzszpitalną u chorych z zawałem serca z uniesieniem odcinka ST, z cukrzycą i bez cukrzycy, leczonych przezskórną interwencją wieńcową

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Streszczenie

Wstęp: Cholesterol frakcji LDL (LDL-C) jest niezależnym czynnikiem ryzyka wystąpienia choroby wieńcowej. Cukrzyca (DM) determinuje gorsze rokowanie chorych z zawałem serca z uniesieniem odcinka ST (STEMI) leczonych przezskórną interwencją wieńcową (PCI). Zastanawiające jest, czy stężenie LDL-C oznaczane w ostrej fazie STEMI może wpływać na śmiertelność.

Cel: Celem pracy była ocena zależności między stężeniem LDL-C przy przyjęciu i śmiertelnością wewnątrzszpitalną u chorych ze STEMI z DM i bez DM leczonych PCI.

Metody: Analizie poddano 1808 kolejnych chorych ze STEMI (378 osób z DM) leczonych za pomocą PCI, w przypadku których były dostępne dane na temat stężenia LDL-C przy przyjęciu. Pierwszym kryterium podziału na grupy była obecność DM, natomiast drugim — stężenie LDL-C przy przyjęciu, bez względu na występujące zaburzenia gospodarki lipidowej. Za punkt odcięcia przyjęto wartość średnią w całej analizowanej grupie, czyli 3,7 mmol/l (143,0 mg/dl). W grupie z DM było 208 chorych ze stężeniem LDL-C < 3,7 mmol/l (143,0 mg/dl) i 170 osób z LDL-C ≥ 3,7 mmol/l (143,0 mg/dl), w grupie bez DM odpowiednio 726 i 704 pacjentów. Analizę zależności między stężeniem LDL-C a śmiertelnością wewnątrzszpitalną przeprowadzono osobno dla chorych z DM i bez DM. Ze względu na możliwą liniową zależność między śmiertelnością a LDL-C, stężenie LDL-C przy przyjęciu w analizie wieloczynnikowej zostało użyte jako parametr ciągły.

Wyniki: Stężenie cholesterolu całkowitego (5,6 ± 1,4 *v.* 5,7 ± 1,5 mmol/l; 216,6 ± 54,1 *v.* 220,4 ± 58 mg/dl; p = 0,21), LDL-C (3,6 ± 1,3 *v* 3,7 ± 1,5 mmol/l; 139,2 ± 50,3 *v.* 143,0 ± 58 mg/dl; p = 0,11) i triglicerydów (1,7 ± 0,6 *v.* 1,6 ± 0,5 mmol/l (150 ± 52,9 *v.* 141,2 ± 44,1 mg/dl; p = 0,30) było porównywalne u chorych z DM i bez DM. Stwierdzono natomiast istotnie niższe stężenie HDL-C w grupie z DM (1,4 ± 0,6 *v.* 1,8 ± 0,5 mmol/l; 53,7 ± 23,0 *v.* 69 ± 19,2 mg/dl; p = 0,049). Śmiertelność wewnątrzszpitalna wynosiła 6,1% i 3,2% odpowiednio dla chorych z DM i bez DM (p = 0,008). U osób z DM śmiertelność wewnątrzszpitalna była zależna od stężenia LDL-C przy przyjęciu i wynosiła 7,1% dla LDL-C ≥ 3,7 mmol/l (143,0 mg/dl) i 4,8% dla LDL-C < 3,7 mmol/l (143,0 mg/dl); p = 0,03. W analizie wieloczynnikowej wykazano, że stężenie LDL-C przy przyjęciu (na każdy wzrost o 1 mmol/l; 38,67 mg/dl) było niezależnym czynnikiem determinującym wyższą śmiertelność wewnątrzszpitalną (OR = 1,45; 1,10–2,00; p = 0,023]. W przeciwieństwie do chorych z DM w grupie bez DM śmiertelność wewnątrzszpitalna nie różniła się istotnie w zależności od stężenia LDL-C przy przyjęciu (2,6% i 3,7% odpowiednio dla stężenia ≥ 3,7 mmol/l; 143,0 mg/dl oraz < 3,7 mmol/l; 143,0 mg/dl; p = 0,21). W analizie wieloczynnikowej stwierdzono, że stężenie LDL-C u osób bez DM nie jest niezależnym predyktorem zgonu wewnątrzszpitalnego (na 1 mmol/l; 38,67 mg/dl; OR = 0,95; 0,70–1,27; p = 0,71).

Wnioski: Wyższe stężenie LDL-C przy przyjęciu determinuje wyższą śmiertelność wewnątrzszpitalną u chorych ze STEMI i DM leczonych PCI, natomiast nie wiąże się z częstą śmiertelnością u chorych bez DM.

Słowa kluczowe: cholesterol frakcji LDL, zawał serca, cukrzyca

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