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Acute myocardial infarction due to the left main coronary artery occlusion: electrocardiograhic patterns, angiographic findings, revascularization and in-hospital outcomes

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ABSTRACT

Background: Primary angioplasty improves outcomes of acute myocardial infarction (AMI). However, in the highest risk subgroups, the mortality remains high despite modern catheter-based reperfusion therapy. This study analyzed patients with AMI caused by the left main coronary artery unstable lesion, a subgroup considered to be associated with very high early mortality.
Methods: A multicenter registry enrolled 6,742 consecutive patients with AMI. Ninety-seven patients (1.4% of the entire study population) had left main as the infarct related artery. Baseline clinical characteristics, ECG patterns, coronary angiographic and echocardiographic data were correlated with the revascularization therapies used and with in-hospital outcomes.
Results: Twenty-five patients (25.8%) died during the hospital stay. The deceased patients were older, had more freqently bundle branch block on the admission ECG, had higher Killip class on presentation, more frequently had TIMI flow < 3 and PCI success rate was 72% (vs. 100% among survivors). Left main coronary artery (LMCA) lesion impaired distal flow (TIMI flow 0–2 on presentation) in 35 patients: the most frequent ECG presentation pattern for these LMCA occlusions was ST segment elevation (n = 17), followed by RBBB (n = 9; with LAH 6 and without LAH 3), LBBB (n = 6) and ST segment depression (n = 3). In other words: acute LMCA occlusion presents in 51% with ECG changes other than ST segment elevations. Patients with TIMI flow 0–2 had higher Killip class on admission, lower ejection fraction and higher in-hospital mortality (37% vs. 20%), when compared to those with TIMI flow 3 on the initial angiogram.
Conclusions: Despite modern interventional therapy, acute myocardial infarction caused by the left main coronary artery obstruction bears high early mortality. The presence of bundle branch block, diminished TIMI flow on the initial angiogram, higher age and Killip class are related with increased mortality.

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SOUHRN

Kontext: Primární angioplastika zlepšuje výsledný stav pacientů po akutním infarktu myokardu (AIM). Nicméně mortalita v podskupinách s nejvyšším rizikem je přes použití moderní katetrizační reperfuzní léčby i nadále vysoká. Cílem této studie bylo analyzovat údaje pacientů po AIM v důsledku nestabilní léze kmene levé koronární tepny, kteří představují podskupinu s velmi vysokou časnou mortalitou.
Metody: Do multicentrického registru bylo zařazeno 6 742 po sobě jdoucích pacientů po AIM. U 97 pacientů (1,4 % celé hodnocené populace) byl infarktovou tepnou kmen levé koronární tepny. Vstupní klinické charakteristiky, tvar EKG křivky a údaje z koronarografického a echokardiografického vyšetření byly porovnány s použitými revaskularizačními technikami a s výsledky léčby během hospitalizace.
Výsledky: Během hospitalizace zemřelo 25 pacientů (25,8 %). Zemřelí pacienti byli starší, v době příjmu byla u nich častěji při EKG vyšetření přítomna blokáda raménka, byly u nich zjištěny vyšší hodnoty Killipovy třídy při příjmu, častěji hodnoty průtoku TIMI < 3 a úspěšnost PCI byla 72 % (vs. 100 % u všech přeživších). Léze kmene levé koronární tepny (ACS) snižovala distální průtok krve (průtok TIMI 0–2 při příjmu) u 35 pacientů: nejčastějším tvarem EKG křivky při těchto uzávěrech ACS byla elevace úseku ST (n = 17), následovaná blokádou pravého raménka Tawarova (n = 9; 6 s LAH a 3 bez LAH), levého raménka Tawarova (n = 6) a deprese úseku ST (n = 3). Jinak řečeno: akutní uzávěr ACS se v 51 % případů projevuje jinými změnami EKG křivek než elevací úseku ST. U pacientů s průtokem TIMI 0–2 byla při příjmu zjištěna vyšší hodnota Killipovy třídy, nižší ejekční frakce a vyšší nemocniční mortalita (37 % vs. 20 %) než u jedinců s průtokem TIMI 3 na vstupním angiogramu.
Závěry: Přes moderní intervenční léčbu je akutní infarkt myokardu v důsledku uzávěru kmene levé koronární tepny stále spojen s vysokou mortalitou. S vyšší mortalitou koreluje přítomnost blokády raménka Tawarova, snížený průtok TIMI na angiogramu při příjmu, vyšší věk a vyšší hodnota Killipovy třídy.

Introduction

Primary percutaneous coronary intervention (PCI) improves outcomes of acute myocardial infarction (AMI) when compared to thrombolytic therapy [1–3]. However, in the highest risk subgroups, the mortality remains high despite modern catheter-based reperfusion therapy. These subgroups include elderly patients, patients with signs of acute heart failure (Killip II–IV class on admission [4]) and patients with critical coronary angiographic findings (left main coronary artery occlusion, last remaining artery occlusion, occlusion of the artery supplying the last viable region of the left ventricle, etc.). This study analyzed one of these high risk subgroups – patients with AMI caused by the left main coronary artery acute occlusion or unstable critical stenosis.

Methods

Patient population. A multicenter registry enrolled 6,742 consecutive patients with AMI, who were admitted to one of the seven participating hospitals during a 3 years period. Ninety-seven patients (1.4% of the entire study population) had left main as the infarct related artery. Baseline clinical characteristics are in Table 1.
Electrocardiographic (ECG) patterns upon admission were registered and assigned into one of the following cathegories: LBBB, RBBB (± LAH or LPH), ST segment elevation, ST segment depression, other ECG pattern.
Coronary angiographic data included the infarct related artery (as assigned by the interventional cardiologist, who performed the procedure), TIMI flow grade before and after PCI, number of major epicardial arteries with > 50% stenosis and the result of PCI procedure. Ejection fraction was registered by echocardiography.

Table 1 – Baseline clinical characteristics of patients with AMI caused by the LMCA occlusion or critical stenosis.

	AMI with LMCA as the infarct related artery	AMI with other infarct related arteries	*P*-value
N	97	6,645	
Mean age (years; SD)	68.9 (11.2)	65.7 (12.0)	0.009
Females	30%	32%	0.742
Diabetes	31%	28%	0.569
Previous MI	23%	21%	0.706
Killip class on admission (mean; SD)	2.25 (1.29)	1.42 (0.83)	< 0.001
Bundle branch block on the admission ECG (LBBB or RBBB)	27%	10%	< 0.001
Ejection fraction (mean; SD)	38.1% (12.4)	48.9% (13.4)	< 0.001
In-hospital mortality	25.8%	5.2%	< 0.001

All these findings were correlated with the revascularization therapies used (PCI, CABG or thrombolysis) and with in-hospital mortality.
Statistical analysis. For continuous variables, mean values and standard deviations were calculated. After checking normality by the Shapiro-Wilk test, Student's two-sample t-test was used for testing of the hypotheses about the means in compared groups. Satterthwaite's correction for unequal variances was applied where appropriate. Mann-Whitney test was used for the ordinal variables (eg. Killip class). Categorical data were tested with Fisher's exact test and Pearson's χ^2 test. All tests have been performed as two-sided on the level of signi-

Table 2 – Comparison of survivors vs. deceased patients with LMCA as the infarct related artery.

	Survived (n = 72)	Died (n = 25)	*P*-value
Mean age (years ± SD)	67.7 (10.7)	72.5 (11.6)	0.062
Females (%)	28%	36%	0.416
Killip class on admission (mean ± SD)	1.95 (1.2)	3.0 (1.2)	< 0.001
Bundle branch block on admission ECG (%)	25%	32%	0.601
TIMI flow 0–2 on presentation (%)	51%	72%	0.101
TIMI flow 3 on presentation (%)	49%	28%	0.101
Ejection fraction (mean ± SD)	39.1% (11.9)	34.7% (14.2)*	0.216
Acute PCI performed (%)	51%	72%	0.101
Acute CABG	28%	0**	0.001
Success rate of acute PCI (% of TIMI 3 flow after PCI)	100%	72%	< 0.001

* EF was calculated only in those patients who survived till post-PCI echocardiography (thus, the calculated value certainly overestimates the value expected in all deceased patients).
** All these patients were in too critical condition (cardiogenic shock, pulmonary edema, resuscitation, etc.) to allow considering CABG.

ficance 0.05. Statistical software Stata, release 9.2 (Stata Corp LP, College Station, TX) was used for the analysis.

Results

Overall mortality among all LMCA – AMI patients. Twenty-five out of the 97 patients (25.8%) died during the hospital stay. The deceased patients were older, had more freqently bundle branch block on the admission ECG, had higher Killip class on presentation, more frequently had TIMI flow < 3 and PCI success rate was 72% (vs. 100% among survivors – see Table 2).

ECG in the subgroup with LMCA functional occlusion. Left main coronary artery (LMCA) was functionally occluded (TIMI flow 0–2 on presentation) in 35 patients: the most frequent ECG presentation pattern for LMCA occlusion was ST segment elevation (n = 17), followed by RBBB (n = 9; with LAH 6 and without LAH 3), LBBB (n = 6) and ST segment depression (n = 3). In other words: acute LMCA occlusion presents in 51% with ECG changes other than just ST segment elevations (Fig. 1). Patients with LMCA functional occlusion (vs. those with initial TIMI 3 flow) had higher Killip class on admission, lower ejection fraction and higher in-hospital mortality (37% vs. 20%) when compared to those with TIMI 3 flow on the initial angiogram (Fig. 2, Table 3).

Discussion

Survival predictors. The main predictors of survival were lower age, lower Killip class on admission and preserved TIMI 3 flow on the initial coronary angiogram. These variables have been shown to predict survival also in other AMI patients [4]. Patients with LMCA critical unstable lesion and TIMI flow < 3 frequently present to the hospital in advanced cardiogenic shock, in pulmonary edema or after resuscitation and thus emergent restoration of the LMCA patency is crucial to keep at least some chance for survival.

Electrocardiographic signs of LMCA acute occlusion. Terkelsen et al. [5] analyzed mortality from acute myocardial infarction in a defined region of Denmark with known population and full coverage of mortality data. They found, that bundle branch block (and especially RBBB) during acute myocardial infarction is related with the highest mortality among all electrocardiographic types of infarction. Similar observations were published by others [6–14]. Hirano et al. [10] found, that 37% of

Table 3 – Comparison of patients with functionally occluded LMCA (TIMI flow 0–2 in LMCA) versus those with critical LMCA lesion, but normal TIMI flow 3 on the acute admission angiogram.

	TIMI flow 3 (n = 25)	TIMI flow 0–2 (n = 35)	*P*-value
Mean age (years ± SD)	68.6 (11.2)	65.5 (11.0)	0.290
Females (%)	28%	20%	0.543
Killip class on admission (mean ± SD)	2.0 (1.3)	3.1 (1.3)	0.002
Bundle branch block on the admission ECG (%)	20%	43%	0.096
Ejection fraction (mean ± SD)	40.7% (14.8)	34.1% (9.8)	0.070
Acute PCI performed (%)	84%	94%	0.223
Emergent CABG	4%	3%	1.000
Success rate of acute PCI (% of TIMI 3 flow after PCI)	100%	86%	0.069
In-hospital mortality	20%	37%	0.253

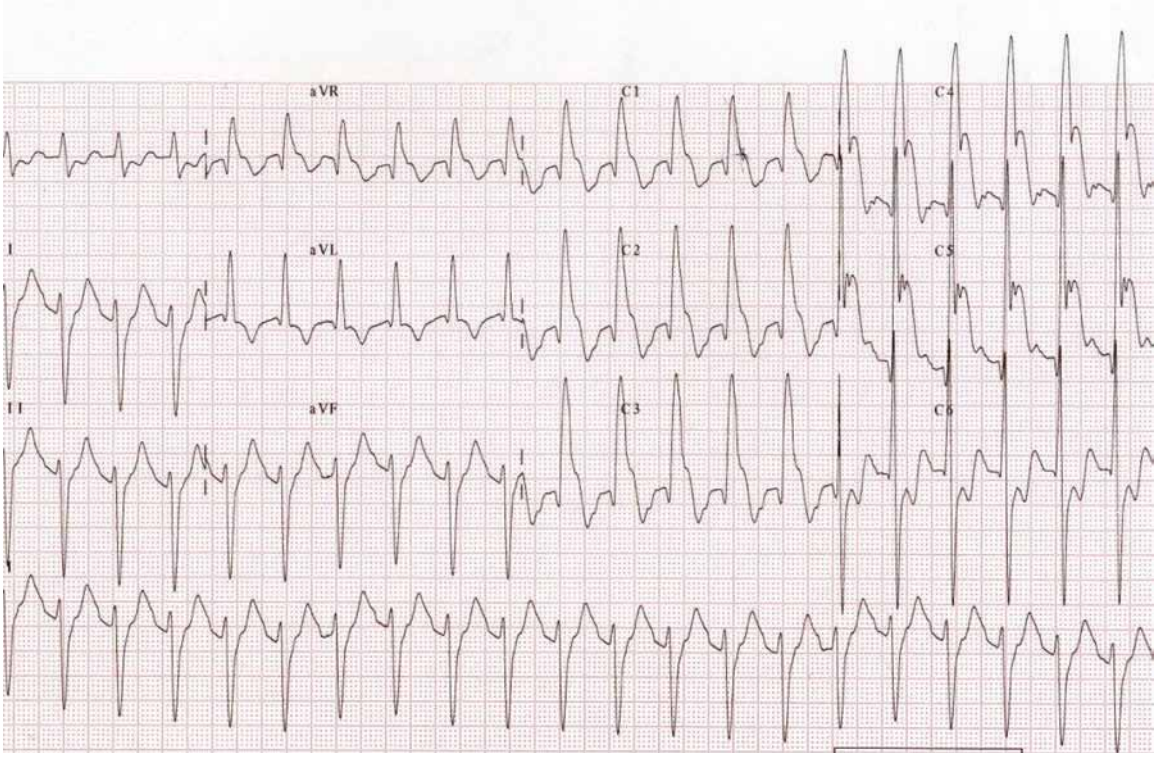

Fig. 1 – Typical ECG from a patient with LMCA subtotal occlusion (99% stenosis with TIMI flow 2). New onset bifascicular block (RBBB + LAH), ST segment elevations in aVR, V1-5, ST segment depressions in I, aVL, V6.

patients with acute myocardial infarction caused by the left main coronary artery occlusion present with RBBB, while only 3% with LBBB. We have shown, that acute LMCA occlusion presents in 26% only with RBBB, without ST segment elevations being in close accordance both with previously mentioned reports and with Hirano et al., who found, that in 30% of left main coronary artery occlusions no ST segment elevation could be found on the admission ECG, while RBBB with left axis deviation (frequently accompanied by ST-elevation in aVR) is typical for this catastrophic type of AMI. The study by Kurisu et al. [11] found RBBB even in 52% of patients with acute occlusion of the left main coronary artery.

Revascularization procedures. The guidelines of the European Society of Cardiology (ESC) list only LBBB as an indication for urgent reperfusion therapy [15]. The Ame-

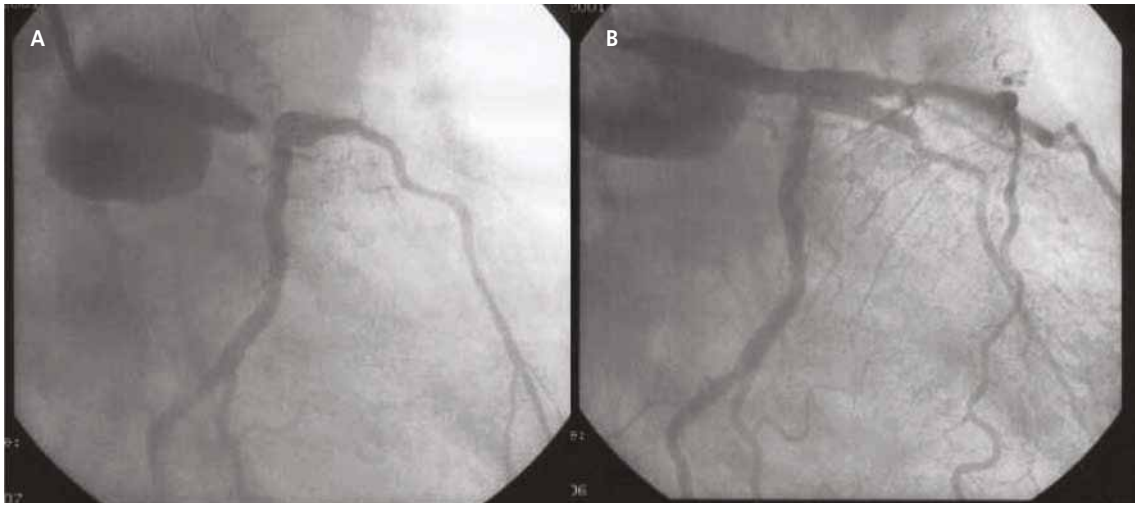

Fig. 2 – Critical (99%) LMCA stenosis and 100% ostial LAD occlusion before (A) and after (B) PCI in the same patients as Fig. 1.

rican Heart Association (AHA)/American College of Cardiology (ACC) guidelines provide similar recommendations [16]. Our recent study [17] suggested, that RBBB should be listed in the guidelines as an indication for emergent reperfusion therapy, preferably by means of PCI. ***Study limitations***. This is not a randomized study, but just a multicenter "real-life" registry. Coronary angiography was not evaluated in an independent core laboratory. This fact may bear inherent risk of interindividual differences in TIMI flow and PCI success evaluation. Moreover, detailed hemodynamic data on admission are not available. However, such a critical setting as LMCA occlusion or preocclusion requires immediate therapeutical intervention and advanced hemodynamic description is not feasible.

Conclusions

Despite modern interventional therapy, acute myocardial infarction caused by the left main coronary artery obstruction has high early mortality. The presence of bundle branch block, diminished TIMI flow on the initial angiogram, age and Killip class are related with increased mortality.

Acknowledgements

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